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Summer Deep-Sky Challenges

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Below are the Orion products from our most recent catalog in greatest demand by serious astronomers and astrophotographers.

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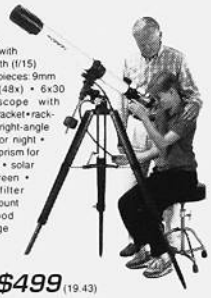
CELESTRON *Classic C-8*

Meade *2045-D Schmidt-Cassegrain*

Tele Vue *Genesis*

Edmund Scientific *AstroScan*

Orion® Sky Explorer 80 Equatorial Refractor



77% more light gathering power than 60mm models • 2-element achromatic 80mm objective lens with 1200mm of focal length (f/15) • two Kellner .965" eyepieces: 9mm (133x) and 25mm (48x) • 6x30 achromatic finderscope with adjustable mounting bracket • rack-and-pinion focuser • right-angle star diagonal prism for night • image-erecting porro prism for day • 2x barlow lens • solar image projection screen • special moon filter • piggyback camera mount • 2-section hardwood deluxe tripod • large equatorial mount.

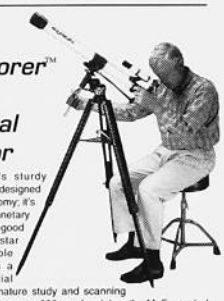
#9098 **$499** (19.43)

Orion® SpaceProbe™ 4.5" Equatorial Reflector

Our affordable reflector for the advanced student of astronomy. 4.5" f/8 reflector gathers 3.6 times more light than 60mm telescopes; twice as much as 80mm models; features a 900 mm focal length and rack-and-pinion focuser. Full featured equatorial mount with slow motion controls & setting circles. Achromatic 6x30 right angle finder and two eyepieces: 25mm (36x) and 9mm (100x). Deluxe hardwood tripod and accessory tray. Compare our price!

#9097 **$399** (18.73)

Orion® Sky Explorer™ 60 Equatorial Refractor



The Sky Explorer's sturdy equatorial mounting is designed specifically for astronomy; it's ideal for lunar and planetary study, while providing good views of nebulas, star clusters, and double stars. By day, it's a powerful terrestrial telescope, great for nature study and scanning distant vistas. It features a 900mm focal length, MgF_2 coated objective lens; 6x30 achromatic crosshair finderscope; rack-and-pinion focuser, fully coated right-angle star diagonal prism; two quality fully coated Kellner eyepieces, 25mm (36x) and 9mm (100x); all metal equatorial mounting; worm gear slow-motion control knobs, celestial coordinate setting circles; dual flexible control cables; adjustable counterweight; adjustable deluxe hardwood tripod; and lighted accessory tray.

#9092 **$329** (12.70)

Orion® Big Eye™ 8x50 & 11x80 Finder Scopes

You might spend more time viewing through the finder than through your main telescope! Big Eye Scope is Ideal for upgrading any telescope including Schmidt-Cassegrains. Available non-illuminated or with wireless, adjustable, battery-operated illuminated reticle and Polaris grid for accurate polar alignment. With 90° diagonal prisms. Optional deluxe dual-ring brackets are perfect for 8" and 10" Celestron or Meade; will fit many others, too.

8x50 Models The 50mm objectives gather 2.7 times more light than 30mm finders!

8x50 Standard Finder #7100
$89.95 (3.31)

8x50 Illuminated Finder #7135
$134.95 (3.56)

Bracket— For 50 mm #5143 **$25.95** (1.89)

11x80 Models These huge finders gulp in over 7 times the light of 30mm finders; 2.5 times more than 50mm models!

11x80 Standard Finder #7146 **$219** (4.16)

11x80 Illuminated Finder #7143 **$269** (4.16)

Bracket— For 80 mm #5140 **$37.95** (2.39)

Superior Performance 7x50 Adlerblick Binoculars

Incredible wide field eyepiece design. Fully Multi-Coated, BAK-4 prisms, and best special glass objective lenses make the 7x50 Adlerblick the arch rival of European brand binoculars selling for 3-4 times the price. Orion buys direct, saving you money. Includes deluxe hard case, lens caps and straps.

#9612 **$269** (4.16)

Orion® 10x70 Fully Multi-Coated Enhanced Giant Binoculars

The standard for hand-holdable astronomy binoculars • 33% lighter—weighs only 58 oz.—yet the same brightness and 7mm exit pupil as our 11x80 MC model • Superior 'BCF' body design • Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

#9501 **$279** (5.87)

Orion® Enhanced™ Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest-field available. Ideal for deep-space observation under dark skies. Hand-holdable.

#9502 **$349** (6.43)

16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended.

#9496 **$379** (6.43)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.

#9498 **$389** (6.43)

Orion® Sky Explorer™ Mini Deep Sky 8x56 Binoculars

56mm objective lenses gather over 2.5 x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view. Weighs 33 oz.

#9504 **$139** (4.16)

Orion® Little Giant™ 9x63 Roof Prism Binoculars

Popular mid-sized binocular. Fully Multi-Coated and remarkably lightweight. Excellent contrast and sharpness at center of field, with enough power to see lunar craters & Jupiter's moons. 5.5° field of view. Weight 34 oz.

#9500 **$199** (4.80)

Orion® 7x50 Observer™ Binoculars

Our new Observer binocular is an ideal moderately priced night-vision binocular for both astronomy and general purpose daytime observation. Fully coated optics with a 7° field of view, and a bright 7mm exit pupil. Rugged ribbed rubber covering for a good grip.

#9620 **$84.95** (3.66)

StereoScope™ Binocular Viewing Expander

Open up a new dimension in observation! The stereo effect of this viewer is astonishing. Viewing is more comfortable and it shows more detail, especially of the moon and planets. Specially built for astronomical telescopes, features a fully adjustable 55-75mm interpupillary distance scale and a highly precise beam splitter which maximizes transmission of light to each eyepiece and equalizes the brightness of each image. Threads securely onto any Celestron or Meade Schmidt-Cassegrain. Includes a thread-on matched 2x Barlow lens. (Shown with two eyepieces, not included.)

#9720 **$399** (3.79)

Orion® 12.5mm Plössl Illuminated Reticle Eyepiece

This new 12.5mm 4-element Plössl offers unprecidented eye relief and observing comfort during long astrophoto exposures. The battery operated integral illuminator has fully adjustable brightness. Features double crossline reticle.

#8484 **$99** (2.79)

World's Finest Illuminated Reticle Eyepiece

6mm Orthoscopic design for required high-power guiding, plus unique X-Y adjustable reticle positioning for easy guide-star alignment. Wireless LED illuminator has adjustable brightness.

#8487 **$139** (2.79)

Orion® 9mm Orthoscopic Illuminated Reticle Eyepiece

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.

#8488 **$119** (2.79)

Orion® 12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into LX/3, LX/5 and Premier drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.

#8482 **$69.95** (2.59)

Orion® 2" Barlow Lens

2x magnification. Multi-Coated, 2-element 40mm diameter achromatic lens. Baffled to eliminate off-axis glare. Works with all 2" barrel diameter eyepieces. Chrome plated brass barrel and blackened aluminum body with knurled set screw.

#8720 **$69.95** (2.59)

Orion® VariPower™ 2-3x Multi-Coated Barlow Lens

Our best barlow fills the gaps in your eyepiece collection • Internal lens cell slides easily to adjust magnification • Quality optics provide excellent sharpness, contrast and brightness • Works with 1.25" diameter eyepieces and right-angle diagonals.

#8748 **$69.95** (2.59)

Orion® 3-Element Fully Multi-Coated Barlow Lens

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" diameter.

#8750 **$59.95** (2.59)

Orion® Deluxe Fully-Baffled Multi-Coated Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.

#8746 **$49.95** (2.39)

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77° Field UltraScan Wide-Angle Eyepieces

Unlimited visibility is yours with up to 77 degrees of field to catch your eye. High quality optical materials and superb coatings, for the ultimate in contrast and resolution.

1.25" UltraScan Eyepieces
Five optical elements utilizing the latest high refractive-index optical glass materials achieve extremely wide fields with fewer elements than many competitive eyepieces, reducing weight and cost. Each lens surface is fully Multi-Coated, for the ultimate in contrast and elimination of stray reflections. Integral rubber eyeguards.

9mm-#8420 **$99** (2.79), *12mm*-#8421 **$109** (2.79)

15mm-#8422 **$129** (2.79), *19mm*-#8423 **$139** (2.79)

2" UltraScan Eyepieces
These incredible oculars provide breathtaking panoramic, bright views that will astonish you!

30mm 2" UltraScan Eyepiece–This 5-element, 77 degree field UltraScan eyepiece combines the widest possible apparent and true fields with a larger image scale than our 40mm.

#8424 **$199** (2.79)

40mm 2" UltraScan Eyepiece - Orion's brightest, widest true-field UltraScan eyepiece utilizes a sophisticated 7-element design, providing a 68 degree apparent field; the widest we could fit into the 2" diameter barrel.

#8425 **$179** (2.79)

High Resolution Orion® Ultrascopic Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Compare with other brands selling for much more!

Wide Field 5-element

35mm #8560 **$89.95** (2.59)

30mm #8562 **$79.95** (2.59)

25mm #8564 **$64.95** (2.59)

Medium-High Power 5-element
20mm #8566, 15mm #8568, 10mm #8570, 7.5mm #8572

$59.95 ea. (2.59)

High-Power 7-element 5mm #8574, 3.8mm #8576

$79.95 ea. (2.59)

Orion® MegaVista™ 1.25" Wide Angle Eyepieces

Incredible Fully Multi-Coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye-relief.

10.5mm- An incredible 67° field for outstanding planetary or deep space performance.

#8552 **$109** (2.79)

16.8mm- Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.

#8554 **$119** (2.79)

Orion® UltraZoom™ 7-21mm 1.25" Eyepiece

The finest zoom you can buy for your 1.25" telescope. An excellent choice for astronomy or terrestrial observing. 65°-35° field.

#8556 **$129** (2.79)

Orion® Explorer Series 1.25" Eyepieces

Remarkably affordable, Multi-Coated parfocal eyepieces with great performance. Each carefully selected series has been chosen to provide a sensible progression of magnifications. Threaded for filters. Internally blackened to prevent stray light reflections.

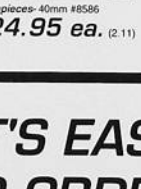
Kellner Eyepieces-
6mm #8536, 9mm #8538, 12mm #8540, 18mm #8508, 25mm #8510, 40mm #8512

$33.95 ea. (2.19)

Orthoscopic Eyepieces-5mm #8500, 7mm #8502, 9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526

$46.95 ea. (2.19)

Orion® Explorer Series .965" Eyepieces



Get the most from your small telescope with these fine Multi-Coated eyepieces. Standard .965" barrels fit all Japanese standard small telescopes.

.965" Orthoscopic Eyepieces-
5mm #8580, 7mm #8581
9mm #8582, 12.5mm #8583

$37.95 ea. (2.19)

.965" Kellner Eyepieces
18mm #8584, 25mm #8585

.965" Achromatic Huygenian Eyepieces- 40mm #8586

$24.95 ea. (2.11)

Orion® SkyGlow™ Enhanced Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters- Photographic and Visual
For use in slight to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces.

#5660 **$59.95** (2.59)

Schmidt-Cassegrain Broadband Filter–fits rear cell of Meade & Celestron SC scopes.

#5658 **$79.95** (2.59)

52mm Broadband Filter–For 52mm camera lenses, adapter rings available for other diameters.

#5668 **$66.50** (2.59)

SkyGlow UltraBlock Filters–Visual Only
For severely light polluted areas and faint nebulae.

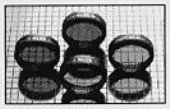
1.25" UltraBlock Filter–fits 1.25" eyepieces.

#5654 **$79.50** (2.59)

Schmidt-Cassegrain UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes.

#5656 **$99.00** (2.59)

Orion® Color Filters for Eyepieces



Solar system observations are dramatically improved by Orion colored filters. For visual use, thread one into the barrel of any standard eyepiece. For planetary and lunar photography, Schmidt-Cassegrain owners can attach the filter to the eyepiece inside the tele-extender. Can also be threaded directly into a universal camera adapter.

Basic Set of 4 Filters .965"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.

#5510 **$29.95** (2.19)

Basic Set of 4 Filters 1.25"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.

#5514 **$39.95** (2.19)

Expansion Set of 4 Filters 1.25"- Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.

#5516 **$39.95** (2.19)

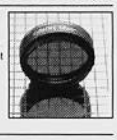
Deluxe Set of 8 Filters 1.25"- Includes all the filters in our basic and expansion filter sets.

#5517 **$74.95** (2.79)

Individual 1.25" Filters- #80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544)

$11.95 ea. (.99)

Moon Filters



Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

.965" #5664 **$14.95** (2.11)

1.25" #5662 **$14.95** (2.11)

Breakthrough Low-Price Plössl Eyepieces!

These new Multi-Coated Plössl eyepieces are incredibly low priced! Good quality optics for sharp, clear images. Precision four-element Plössl lens elements mounted in sturdy aluminum barrels. Available in 12mm, 18mm, or 25mm focal lengths, with 1.25" barrels. Buy all three for less than some single eyepieces!

12mm-#8596
18mm-#8597
25mm-#8598 **$39.95 ea.** (2.39)

Deluxe Eyepiece Case

Organize and protect your valuable eyepieces and other accessories. This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug secure fit. O.D. 8-1/2"x12-1/2"x3-1/8".

#5913 **$17.95** (2.49)

Deluxe Metal-Clad Accessory Cases

Keep accessories and camera safe and clean. Diced foam inserts can be tailored to your needs. Sturdy handle, two latches, key.

Regular Case: 16"x12"x6 1/2"

#5920 **$49.95** (5.09)

Large Case: 19 1/2"x12"x6 1/2" #5921 **$69.95** (5.92)

Deluxe Field Tripod Tote Bag

Designed for the field tripod with padded insert to separate wedge from tripod during transportation. Specifically made for wedge combinations of Schmidt-Cassegrain telescopes up to 10" aperture. Allows storage without changing polar alignment. This blue bag is made of tear, rip and mildew resistant 100% Cordura nylon.

#15096 **$79.95** (4.65)

Orion FlexiShield™ Dew Caps

Eliminate dew problems with FlexiShield! Better performance, more rugged, and easier storage than rigid dew caps. Forms into a tube with the velcro closure, opens flat for easy storage and transportation. Fits your telescope tube snugly, with wide rubber padding and full-length velcro closure—needs no screws. Models to fit most telescopes.

90mm Celestron/Meade Spotting Scopes	#4203	**$24.95** (2.39)
90mm Celestron Rubber Armored Spotting Scopes	#4205	**$24.95** (2.39)
4" Meade Schmidt-Cassegrain	#4204	**$24.95** (2.39)
8" Celestron/Meade Schmidt-Cassegrains	#4200	**$39.95** (2.39)
10" Meade Schmidt-Cassegrains	#4201	**$49.95** (2.39)
11" Celestron Schmidt-Cassegrains	#4202	**$59.95** (2.39)

Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

8" Dew Zappers- fit all Meade & Celestron 8" Schmidt-Cassegrains

DC Model #3503, AC Model #3504 **$39.95** (2.39)

10" Dew Zappers- fit all Meade 10" Schmidt-Cassegrains

DC Model #3506, AC Model #3508 **$39.95** (2.39)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 156 watt warm air gun. Has 4-1/2' cord.

#5601 **$17.95** (2.48)

Orion® Slow-Motion Adapter

Attaches to your tripod pan head and gives you two slow-motion control knobs to make precision adjustments in altitude and altazimuth. Very handy for tracking planets, the moon, etc. with refractor telelscopes and small spotting scopes. Attaches to any camera tripod with a standard 1/4-20 thread.

#7012 **$49.95** (2.59)

Orion® Dual Balance System

Unlike ordinary counter-weights, our system allows instant adjustment in both directions. Easily balances your scope to offset both piggyback loads or rear-cell cameras, 2" diagonals, and other accessories. Rigid, precision machined dovetail bar mounts to telescope in existing accessory holes.

For Meade SC 8"	#5150	**$74.95** (4.65)
For Celestron 8" C-8	#5149	**$79.95** (4.65)
For Meade SC 10"	#5152	**$84.95** (4.65)

Starlite Red LED Flashlight

The Starlite is the only adjustable-brightness night-vision red flashlight. Lifetime solid-state LED can't burn out. Extra efficient electronic circuit for long battery life. Uses one 9-volt battery (not included).

#5714 **$24.95** (2.11)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. An essential addition to your astronomy accessories. Requires 2 D-cell batteries (not included).

#5701 **$9.95** (1.89)

Rechargeable Battery Porta-Pack

12 Amp Hour Porta Pac
Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high-impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt. 10 lbs.

#2354 **$99 ea.** (6.23)

Popular Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model-
Has adjustable-height center column and padded vinyl seat. Folds for easy storage.

#5935 **$39.95** (3.96)

Deluxe Model-
Is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable and disassembles for storage.

#5934 **$89.95** (5.65)

Orion® UltraGuider™

Advanced features most requested by advanced deep-space astrophotographers at a low price • Use with your Meade or Celestron Schmidt-Cassegrain telescope • Easily adjustable prism allows wider choice of guide stars • Ultra-precise helical focus of your eyepiece • Adjustable camera focal plane position

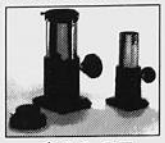
#5139 **$119** (2.79)

Orion® Premium Off-Axis Guider

Multi-Coated for Peak Performance! • Low Orion price for our popular, precision anodized guider

#5144 **$59.95** (2.59)

Rack & Pinion Focusers



These top quality focusers are designed for Newtonian reflectors. Fit any size tubes.

1.25" Focuser
Quality diagonal-cut rack for smooth focusing. Secure slide-fit eyepiece holder. Integral socket for single-stalk diagonal support if desired.

#13017 **$44.95** (2.39)

2" & 1.25" Focuser
Large clear diameter ideal for larger scopes and wide-field optics. Precision diagonal cut rack. Long travel for visual and photographic use. Interchangeable 2" and 1.25" holders with set screws.

#13019 **$69.95** (3.31)

Orion® 45-Degree Erect Image Diagonals

See the world as it really is with Orion's new 45-degree erect image diagonal. Upside-down, backwards and topsy-turvy images can often confuse even the stoutest and most experienced observer. Turn it right-side-up with your choice of three models to select from:

.965 Diagonal #8759 **$59.50** (2.59)

1-1/4" Diagonal #8753 **$59.50** (2.59)

Size-Adapting Hybrid Diagonal #8755 **$59.50** (2.59)

Star Diagonals

1.25" Star Diagonal
Primarily for astronomical use, lets you view at a right angle. Multi-coated, for 1.25" eyepieces.

#8763 **$39.95** (2.39)

.965" Star Diagonal
Same as 1.25" Star Diagonal, but with standard coated optics. Works with .965" eyepieces and eyepiece holders.

#8761 **$24.95** (1.89)

2" Star Diagonal

Get the widest possible field of view from your Schmidt-Cassegrain Telescope. This star diagonal features a special aluminized and overcoated precision first-surface flat mirror.

#8767 **$89.95** (2.89)

Orion® Tele-Extenders

For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.

Standard Tele-Extender
Use this Tele-Extender in conjunction with an eyepiece. Attaches to visual back of Meade or Celestron Schmidt-Cassegrain telescopes, and to 35mm camera with T-ring, sold separately.

#5125 **$27.95** (1.89)

Variable Tele-Extender
Uses an adjustable extension tube, allowing magnification to be changed without switching eyepieces. Attaches with T-ring, sold separately.

#5127 **$39.95** (1.89)

Universal Camera Adapters

Standard Universal Camera Adapters
Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring (sold separately) to match your 35mm camera.

.965" #5268 **$29.95** (1.89)

1.25" #5264 **$34.95** (2.39)

Variable Power Camera Adapter

Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes are required.

#5262 **$44.95** (2.39)

Orion® T-Adapter

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 4", 8", 10", 11", 14" SC. Can be used as 2" camera adapter.

#5116 **$27.95** (1.89)

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IT'S EASY TO ORDER

- Call Toll-Free and charge to your MasterCard or Visa or send your personal check to order by mail.
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DEEP SKY

THE MAGAZINE FOR DEEP-SKY OBSERVERS AND ASTROPHOTOGRAPHERS

FOUNDED IN 1977 BY DAVID J. EICHER

SUMMER 1991 VOLUME 9, NUMBER 3

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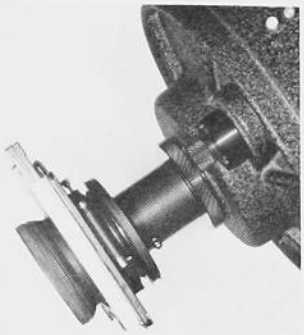

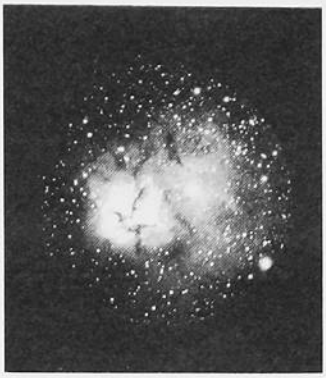

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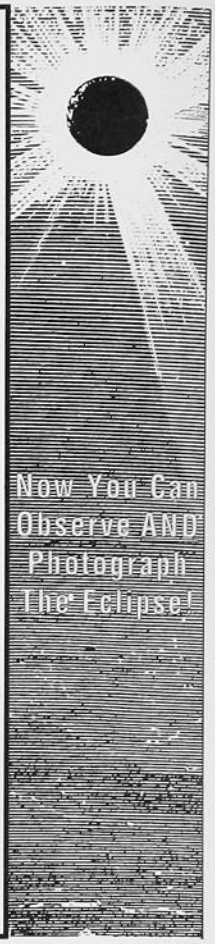

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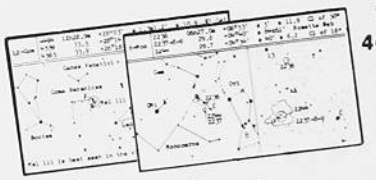

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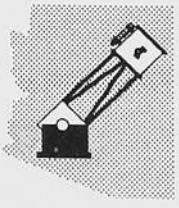

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AT THE EYEPIECE

Welcome to another issue of *Deep Sky*. Now that warm weather is here again, we'll head outdoors for long sessions under the stars. Why not try something new this year? With low-power telescope or binoculars, slowly scan the Milky Way and soak in the beauty of what you see. Rather than seeking out the best and brightest objects, let the rich nature of the Galaxy bring into view what comes by chance. You'll enjoy what you see greatly and the element of surprise adds to the fun.

In our story "The Splendor of the Milky Way" (page 24) you'll see some outstanding panoramic photos of the Galaxy made by Flavio Lobos Martins. We're proud to present his work here. On page 32 Tom Johnston offers up a long list of galactic goodies for telescopes of all sizes in his story "Treasures of the Galactic Core." Brian Skiff's double star column presents "Sweeping the Galactic Plane in Cygnus." That should give you plenty of things to look at in the Milky Way!

Skiff's lead article recounts his trip to Las Campanas in Chile ("View with a Room," page 12). We should all get the chance to go south for dark sky observing, but until we do, Brian's article offers a journey of the imagination matched by few other written pieces.

I'll look forward to talking with many of you at summer conventions this year. Look for me at the Texas Star Party in Fort Davis, Texas (May 16-19), the American Astronomical Society meeting in Seattle, Washington (May 26-30), ALCON '91 (August 7-9) and Stellafane (August 9-10).

Dave Eicher

Remembering an Iowa Night

Dear David / Your Winter issue arrived the week before Christmas, and having a few quiet moments between shopping, wrapping, and cooking for family members coming in from out of town, I sat down to absorb the contents of your magazine. The article that brought me to writing this letter is "Women Reach for the Stars at TSP," by Robert Reeves.

To be able to sit and read about how other women became interested in astronomy was a great coincidence. The week before, at a dinner for members of the San Bernardino Amateur Astronomers, I sat across the table from a very nice gentleman who commented that it was "unusual for a woman to be so interested in this science." I told him a story nearly identical to those in the article.

When I was young my father took my sister and I out into the Iowa night to observe meteor showers, teach us the names of the stars in the Big Dipper and tell us the legends of the constellations. Once he took us out to show us an aurora rippling in great folds of light across the black sky. My father also told us about seeing Halley's Comet when he was a little boy, and explained to me that he would be gone when it returned and I would have to look for it for him. And I did.

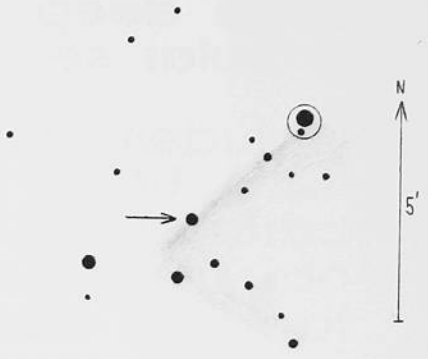
But, of course, it didn't end there. I am fortunate to have access to a community college that offers courses in astronomy. And I've become a member of the San Bernardino group. I hardly think my interest was caused by a gene attached to a chromosome; in fact, I can't imagine not being interested in astronomy.

Please convey my appreciation to Robert Reeves for his article. — *Joan DeVillier, 3280A Little Mountain Drive, San Bernardino, California 92405*

Another Country Heard From

Dear Colleagues / I am a 13-year-old amateur astronomer from Czechoslovakia. I would like to share the following notes of some of my observations made with a 63mm refractor. I hope your readers enjoy hearing about these observations which I had so much fun making.

Several months ago I began observing five open clusters between the stars Delta and Epsilon Cassiopeiae. I used only a small telescope, a Zeiss 63mm refractor with magnifications up to 84x. But it is possible to make nice sketches, even with this type of telescope.



M103 sketched by Martin Konecny using a 63mm refractor at 34x to 83x.

I observed M103 (NGC 581) first. There are two prominent stars just north of the cluster, comprising the double star Struve 131. The pair is circled in my sketch, and the star indicated by an arrow is strongly red. Trumpler 1 lies 40' north-northeast of M103. This group appeared only as a bright, hazy star at a magnification of 34x. I estimated its magnitude to be between 8.5 and 9.0. Two bright stars on the edge of my sketch are plotted on Uranometria 2000.0.

NGC 654 is a very nice cluster as large as M103. The haze from its unresolved stars is conspicuously granular. The group NGC 659 is slightly fainter and smaller than NGC 654. Finally, NGC 663 is the most beautiful of all five clusters. It is a large star group with brilliant, white stars and a large dark area near its center. This cluster deserves to be a Messier object more than M103! — *Martin Konecny, Rude Armady 41, 678 01 Blansko, Czechoslovakia*

Reviewing the Reviewer

Dear Mr. Eicher / I would like to comment on a book review by Mark J. Coco (*Deep Sky* Reviews, Winter 1990-1991). In his review of *Bright Star Atlas 2000.0* by Wil Tirion, Mr. Coco mentioned many good aspects of the book that I agree with. In fact, if it were not for one very important characteristic, I would have been happy with the

book and wouldn't have sent it back for a refund.

Did Mr. Coco look at the maps under red light? Apparently not. Under such lighting, everything in the broad band of the Milky Way becomes invisible. Because I intended to use this atlas in the field — the use for which the book is intended — this is an intolerable fault. I think that your reviewer should "field test" each atlas or chart in a given book to make sure it works well in actual observing conditions. — *Ted Aranda, 5419 South Harper, #110, Chicago, Illinois 60615*

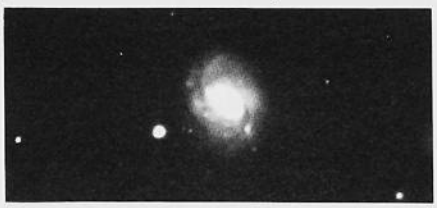
Association of Binary Star Observers

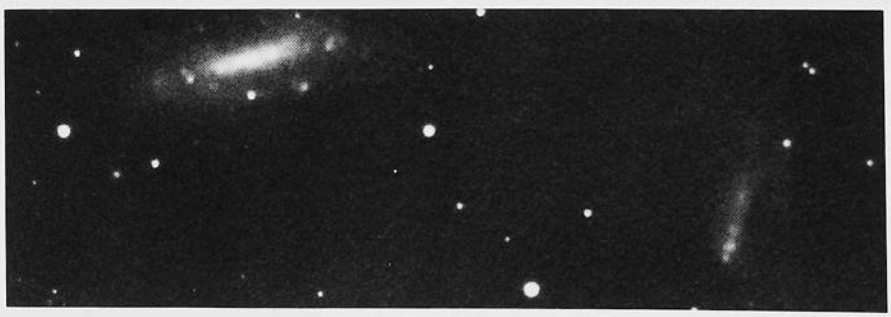
Dear Mr. Eicher / I am proud to announce the formation of the Association of Binary Star Observers (ABSO), a group of amateur astronomers around the world interested in studying double star astronomy. The purpose of the ABSO is fivefold. We will provide members new to double star astronomy with information on how to begin making measurements. We will provide members with information on various methods of double star measurement, catalogs, books, observing aids and telescopes. We will provide members with information on how to have their double star measurements examined and published by professional astronomers. We will provide an opportunity for double star observers to become acquainted with one another. And finally, we will keep members informed through our quarterly journal, *Binary Star*.

Amateur astronomers who have a micrometer are in the special position of being able to make significant contributions by measuring binary stars. However, serious double star work is currently neglected by amateurs. This need not be the case: a diffraction grating micrometer (DGM) can be made from household materials, and does not require a telescope with a clock drive to be used effectively.

The lack of interest in double stars by amateurs is due primarily to the absence of an organization promoting this area. Because there are so few professional astronomers currently engaged in measuring visual double stars, observations by amateurs can be of great value. Charles E. Worley of the U.S. Naval Observatory has said that "there are lots of immediate pairs, 1 to 10 arcseconds apart, that have languished in the catalogs for many years — a vast number that amateurs could profitably remeasure."

Brian Skiff of Lowell Observatory has agreed to act as a source of advice and information to the ABSO. The well-known double star observer Mark



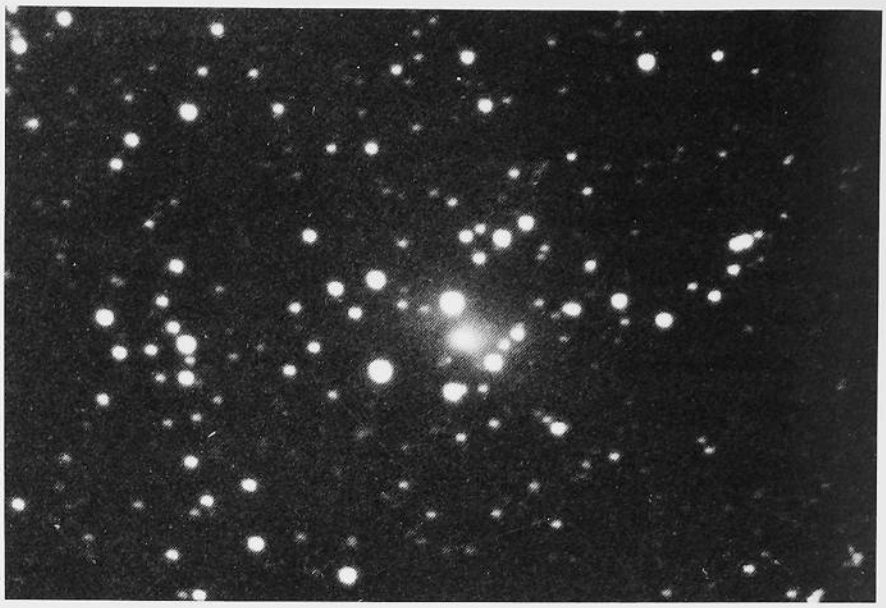


Unusual galaxies photographed by the talented James R. Foster: NGC 772 and NGC 770 (above) photographed with an 11-inch SCT at f/10, hypered Tech Pan film, and a 210-minute exposure. NGC 4535 and NGC 4535A (left) photographed with an 11-inch SCT at f/11, hypered Tech Pan film, and a 210-minute exposure. M77 (below) photographed with an 11-inch SCT at f/15, hypered Tech Pan film, and a 150-minute exposure. NGC 672 and IC 1727 (bottom) photographed with an 11-inch SCT at f/11, hypered Tech Pan film, and a 195-minute exposure.

Stauffer of Baton Rouge, Louisiana, is the assistant director of the group. Barbara Lux of McKeesport, Pennsylvania, is the group's observing program chairperson and is in charge is our use of the Washington Double Star Catalogue (WDSC).

The ABSO has received support and recognition from many professional double star astronomers, including W. D. Heintz, C. E. Worley, and Don Barry. Additionally, Robert W. Argyle, a professional double star astronomer at the Royal Greenwich Observatory in England, has agreed to lend us support.

Deep Sky readers interested in joining the ABSO should forward a check or money order for $15 (annual dues) payable to the Association of Binary Star Observers. If you wish to obtain further information and a sample copy of our journal, please send a check or money order for $3. — *Ronald C. Tanguay, director, Association of Binary Star Observers, 306 Reynolds Drive, Saugus, Massachusetts 01906*



The elusive galaxy Maffei 1 photographed by James R. Foster (11-inch SCT at f/11, hypered Tech Pan, print made from two sandwiched negatives of 150-minute and 90-minute exposures).

Unusually Neat Galaxies

Dear Dave / I'm enclosing some photos of unusual galaxies for the enjoyment of your readers. The first photo shows galaxies NGC 770 and NGC 772 in the constellation Aries. The exposure time was 210 minutes, and I used an 11-inch f/10 SCT, hypered Tech Pan, and an SBIG autoguider for the shot. There are three reasons why the photo isn't technically as good as it could have been. First, occasional wind gusts made the tracker lose the star. Second, since I passed the central meridian, the mirror may have rotated slightly while the guide star remained fixed. Third, the CCD/off-axis guider was loose relative to the camera. My second shot shows M77 in Cetus, an autoguided exposure of 150 minutes duration. I used the 11-inch SCT at f/15 and hypered Tech Pan for this shot.

Another photo shows a pair of galaxies in Triangulum, NGC 672 and IC 1727. NGC 672 is an SBc III galaxy whose orientation is almost edge-on relative to our line of sight. IC 1727 is an SBm III-IV galaxy that is possibly a dwarf spiral. The difference in apparent luminosity between NGC 672 and IC 1727 is dramatic. Despite that IC 1727 is 8.7 percent closer to us (based on radial velocities), it is only 20 to 40 percent as bright as NGC 672. Could the radial velocities be somewhat off and could these galaxies form a physical pair?

I'm also enclosing a photo of Maffei 1 which I was inspired to take after reading Don Pearce's article "The Illusion of Maffei 1" (Autumn 1988 issue). I took two shots of Maffei 1, exposures of 150 minutes and 90 minutes. I sandwiched the negatives together and printed the resulting negative with my enlarger's highest magnification. Although the detail is somewhat better than Marty Germano's shot that ran with the article, I decided to sketch an enlargement of it to show the outer detail around the galaxy. My sketch does not show the large extensions Don saw visually, but it does show that the galaxy's misty outer envelope fills slightly less than half of the "trapezium" of stars lying in front of the galaxy. — *James R. Foster, 1335 North Poinsettia Place, #4, Hollywood, California 90046*

Observing in Northern Canada

Dear Dave / I'd like to share with other readers some interesting observations I made from Cape Parry in northern Canada (70°10' N, 124°40' W). I've long been fascinated by nebulae within the Galaxy, and in April 1989 I purchased the last 5-inch f/5 doublet refractor from D&G Optical, primarily to facilitate their study. The tube is 6 inches in diameter and the focuser is a 3-inch o.d. type designed by the firm. I optimized contrast transfer by coating the inside of the optical and focuser tubes with flat black paint and sawdust, and found that no other baffling was required. Looking down the tube is like peering into a mine shaft, and, indeed, the exit pupil is surrounded by a sizeable annulus of perfect blackness, outside of which lies some scattered light from the inside walls of my 2-inch mirror diagonal. The objective, with its cemented crown and flint elements, is as good as can be had, although it naturally gives horrendous secondary color on bright stars at high powers. For low to medium deep-sky viewing, however, this scope is a performer.

To view large objects I principally employ a 32mm Erfle with a 2-inch barrel. This ocular has no field stop and provides an apparent field of about 75°. Installed in the 5-inch scope, the resulting magnification is 18x, the exit pupil is 7mm, and the true field is 3.9°. More detailed views were provided with 24mm (26x) and 15mm (42x) Widefields and a 7mm (91x) Nagler. I further scrutinized the nebulae with a 48mm UHC filter threaded into the diagonal.

Because of the high latitude of Cape Parry, we have 73 days of continuous sunup centered on the summer solstice. All-night twilight on each end of this period limits our dark sky observing to the dates between mid-September and the end of March. This is barely over six months! Some handicaps to winter observing are: arctic haze, ice crystals falling from otherwise clear air, all-sky auroral displays, four-to-five-day periods of circumpolar moonshine, numbing -30° to -40° C wind chills, and, to top it all off, frequent cloudiness. The best observing period starts in early December. During the summer and fall (and occasionally in the early spring), the air itself is astoundingly transparent. If Earth's surface could be made flat, I'd estimate that horizontal visibility would exceed 200 kilometers. The absence of manmade light pollution results in skies certainly the equal of those over the Australian outback, if not better. It's too bad they are so infrequent!

During the autumn of 1989, I put my new scope through the paces, and saw things I had thought, until then, were unobservable. For most of the observing sessions I ascertained a naked-eye limit of magnitude 7.0 to 7.5, with M33 easily visible unaided without much difficulty, and the North America Nebula and M13 quite easily seen.

For telescopic study, my first target was the North America Nebula (NGC 7000). Its large size and reasonably high surface brightness make the North America a relatively easy object. At 18x it fit quite comfortably within the field of view, and its characteristic shape could be discerned. Through the UHC filter the nebula really looked good, with a marked increase in contrast and a very well-defined northern edge. At 26x and 42x subtle differences in brightness across the nebula were visible. The nearby Pelican Nebula (IC 5067-70) was barely detectable without the UHC, but through the filter the Pelican's "head" and "bill" could be faintly discerned at 26x and 42x.

To study IC 1318, the complex of nebulosity around Gamma Cygni, I used only the 35mm ocular. Just a small amount of sweeping was required to appreciate the overall structure of this field. Without filtering, the two brightest stars were detectable, but I suspect more nebulosity would have manifested itself if not for the plethora of stars filling the view. By using the UHC filter more "stuff" popped into view, due partly to the starlight being suppressed. Now the three brightest knots were readily apparent, with a few areas of much fainter, diffuse nebulosity scattered throughout. This area deserves careful and prolonged scrutiny.

The Veil Nebula (NGC 6960, NGC 6992-5) was fascinating to observe over a wide range of magnifications. An unfiltered view at 18x showed both halves reasonably well; the eastern loop's "iota" shape was obvious. Increasing magnification improved visibility and detail, but only by using the UHC filter did I get a pleasant jolt. The crudely wedge-shaped just northwest of a point between the two main loops (NGC 6979) was just visible at 26x and 42x. At 91x this feature became difficult because it was so spread out, but at this magnification the convolutions in NGC 6995 were nicely resolved.

I found the next pair of objects fascinating because I kind of "discovered" it. In the winter of 1983-1984 I was beginning rudimentary photography with a camera-on-tripod setup from Cape Parry during my first tour of duty as a weather observer. I had recently purchased an Astroscan telescope, but the only deep-sky objects I was observing were about half or so in the Messier list. All of those big blobs of green plotted on my Becvar *Atlas of the Heavens* seemed beyond the realm of observation. On one cold night I was shooting 60-second exposures of the Milky Way with a 50mm f/1.4 lens on the then-new Kodacolor 1000 film. At 30° C the film was effectively chilled, and I was astonished at what I'd recorded.

In an exposure showing the area between Perseus and Cassiopeia there were two fuzzy, reddish smudges a few degrees northeast of the Double Cluster. Excitedly checking my atlas, I found them to be IC 1805 and IC 1848. They're both approximately 1.5° across, so I reasoned that binoculars would be the instrument of choice to glimpse them. Subsequent attempts through the years with 7x50s and 14x70s netted nothing. (Although a few times I did see the nearby, brighter nebula IC 1795 with the larger instrument.) Last autumn I tried the area with the 5-inch scope. Looking straight overhead at the area, I was quite surprised to see both IC 1805 and IC 1848 for the first time. Hardly able to contain myself, I threaded in a UHC filter. What a sight! IC 1805 looked like a cutaway view of an assymetric, valentine-shaped heart, complete with auricle and ventricle. IC 1795 was rather bright, just off the point of the "valentine." IC 1848 appeared crudely bar-shaped, and of the same surface brightness as IC 1805. At 26x and 42x more structure became apparent, especially in IC 1795, which bears magnification well.

Due to its elevation being no higher than 50° when I observed it, the California Nebula (NGC 1499) wasn't as good as it could have been. Nonetheless, I did succeed in sweeping it up, unfiltered, at 18x and 26x. Nearby, bright Xi Persei didn't help the nebula's visibility, either. Through the UHC filter, nearly the full extent of the nebula was visible. At 26x and 42x, a "gap" running half the length of the nebula from the western end reminded me of a distorted view of a partially open bird's beak. Moderate magnification seems to show the subtle detail of this object best.

The last object on this tour of faint nebulae was IC 1396 in Cepheus. Of all the targets on my list, this was the one I'd had no real hope of seeing. I've read about IC 1396 as a challenge for photographers, and my own shots show it to be fainter than IC 1805 and IC 1848. Reddish Mu Cephei, located on the northern edge of the nebula, serves as an excellent guidepost. But no amount of unfiltered sweeping picked anything up, except for a fog of stars. Using the UHC filter at 18x, however, I saw the nebula as faintly visible. It appeared to have a diameter of about 2° and a fairly well-defined edge. The only detail I saw was a large-scale variation in brightness.

For me, these observations have been a personal milestone in faint object detection. Now I feel that I can safely say that just about any faint nebula that can be recorded unambiguously on common color photographic emulsions can be seen with high contrast, wide-field optics used with a narrow bandpass nebular filter. It is a stunning conclusion to reach! — *Glenn LeDrew, AES Pin Main, P.O. Box 40, Cambridge Bay, Northwest Territories, X0E 0C0 Canada*

Deep Sky Desert Storm

Dear Dave / As a naval aviator stationed aboard the U.S.S. Midway in the Arabian Gulf during Operation Desert Storm, I have not had much time to devote to my love of astronomy and especially astrophotography.

However, I want to let you know that despite the many holdups in the mail my copy of *Deep Sky* arrived faithfully way out here in the Gulf — and on time!

During those rare moments when I got to the signal bridge at night I would take a few minutes to point binoculars at a familiar celestial object and describe it to the signalmen. Orion was a favorite and appropriate object considering our circumstances. I have definitely xcreated a small but interested group of budding amateur astronomers on this ship!

I also want to tell you what a difference your publishing work has made for us at my last command on the island of Kauai in Hawaii. I was fortunate enough to be instrumental in forming an astronomy and science society that has since begun constructing a community observatory in partnership with Kauai Community College and the Pacific Missle Range Facility to be used for educational purposes. The observatory will contain a 16-inch Cassegrain telescope complete with CCD equipment, a television monitor, an 18-inch f/7 Dobsonian, and a restored 6-inch refractor.

During our monthly star parties the latest copy of *Deep Sky* and a couple of well-used copies of *The Universe from Your Backyard* often replace star charts for those who attend. Thank you for your leadership and the direction you've provided in your fine and practical publications. — *Lieutenant Tom Poff, United States Navy, Operations Department, U.S.S. Midway, FPO San Francisco, California* □

View with a Room,

or *Un hombre del nocturno en Observatorio Las Campanas*

Join our senior contributing editor as he travels south for the observing experience of a lifetime.

by Brian A. Skiff

"It's okay if you talk to yourself," Oscar was telling us, nodding vigorously and raising his dark eyebrows. This is not the first time he's given this whimsical advice to guest observers. "And it's even okay when you start to talk to the rocks." He gestured out the dining room's picture windows across the barren ridge, an aerie in the Andean foothills above Chile's arid Atacama Desert, Earth's driest. "But if the rocks start talking back, then you must get off the mountain right away!"

Carmelle Robert and I are chatting over dinner at sunset with Oscar Duhalde, instrument technician at Las Campanas Observatory, known for his role in the discovery of the LMC supernova 1987A. Carmelle mentioned that she'd started talking to herself during the nightly tedium of doing photopolarimetry of Wolf-Rayet stars with the University of Toronto's 60cm telescope. She is about to finish work on her Ph.D. at l'Universite de Montreal, and this may be her final observing run as a student — not a time to go crazy. But two weeks on an isolated mountaintop with few distractions was starting to get to her. I commiserated, saying I'd started it, too. "Just turn the music up louder," I recommended.

My part in this conversation was many months in coming. Having pretty well completed visual surveys of the northern sky, I was keen on finding out about the south. We've all seen photos and read about the Clouds, the Eta Carinae Nebula, the Coalsack, Omega Centauri, the brilliant Milky Way from Puppis to Norma. I wanted to see all these spectacular views plus the ordinary ones that make up the bulk of the numbers of deep-sky objects. Not since John Herschel's years at the Cape — 150 years ago — has a thorough visual survey been completed of the southern sky and seen the light of day in print. Through an arrangement with its headquarters in Pasadena, California, I was able to spend three weeks at Las Campanas Observatory beginning in mid-February 1990 to make a start toward this goal with my 6-inch refractor.

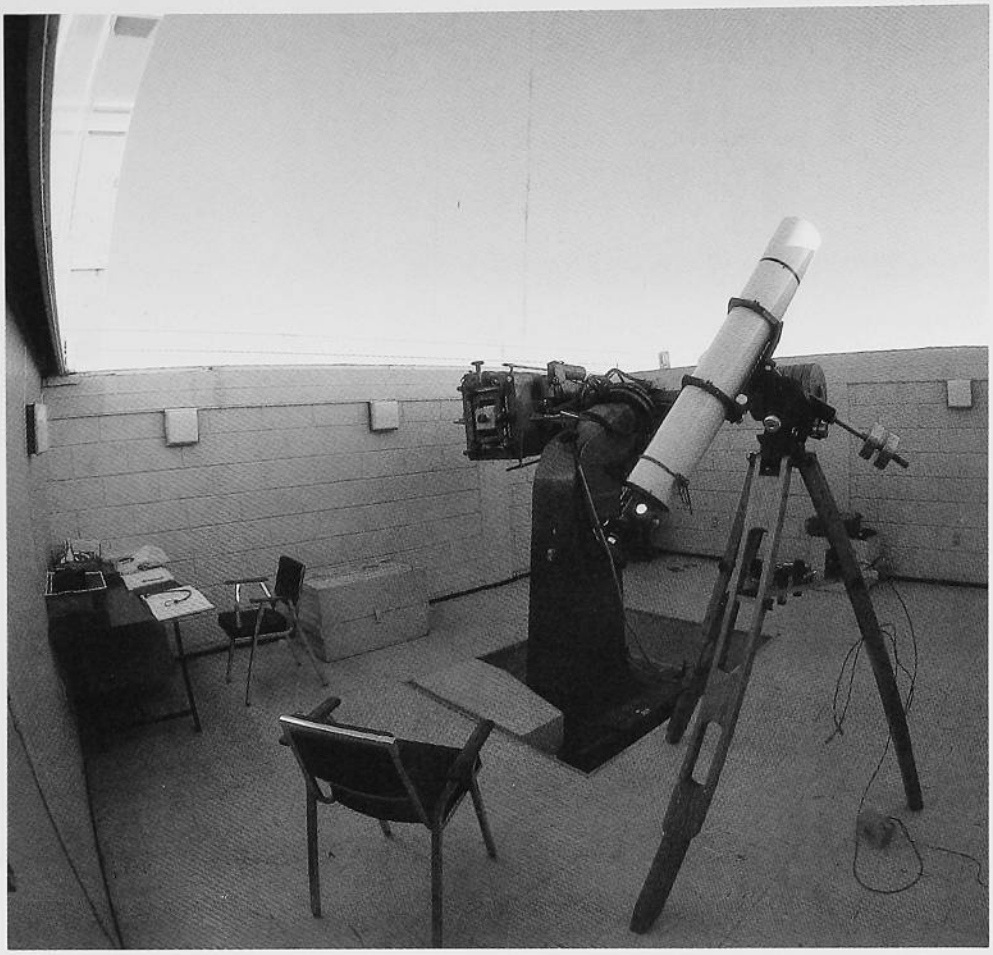
The trip was a very long one, but worth it. During the twenty-one nights I was actually at Las Campanas, nineteen were "photometric," or cloudfree. This was not unusual for the region: there is rarely much weather of the ordinary kind from October through March; on average the site receives less than 4 inches of precipitation each year. What's more, because the observatory is at 2300 meters elevation, the atmospheric transparency is similar to that of the best sites in the American southwest. Actual observation proved that the site also delivers exceptionally stable seeing. This combination of persistent cloudfree skies of high transparency and excellent seeing is unexcelled anywhere in the world. I had originally considered going to Australia, but inquiry revealed that no place on that continent even comes close to matching Chile's sky quality. Dark skies, yes; clear, steady skies, no. During my nights in Chile, I made observations of over 600 objects.

So on a frigid February morning I left Flagstaff laden with three heavy boxes holding the telescope hardware besides an ordinary suitcase and carry-on pack, in which I carried the telescope's triplet objective. At airport baggage checkpoints, the objective (and its cell) caught the eye of many an operator of x-ray metal detectors. In Los Angeles, after I was pulled aside for a show-and-tell ("What's that round thing?"), the security guard gasped when she saw the lens, as though it were a giant fine-cut diamond. No, not a bomb. Have a nice trip.

The telescope boxes proved to be a burden as well. When traveling by plane, what one considers a "portable" telescope shrinks considerably! However, after paying for excess baggage (overweight and over-length) in Phoenix, I didn't have to deal with them until 36 hours later in Santiago, Chile, despite airline and flight changes.

One service the observatories provide is someone to meet you at the Santiago airport, who either takes you to an observatory-owned guesthouse for an overnight stay (if flight schedules do not work out), or whisks you through customs and gets you into the right line at the ticket counter for the short flight up to La Serena. It was sultry and smoggy in Santiago, and I was drained from the long flight. But Señor Tosselli was cheerful and efficient. "¡Mucho gusto, señor, mucho gusto!" he said in greeting, spotting the obviously bewildered "norteamericano" astronomer in the crowd coming off the 747. Tosselli convinced the customs agents that my boxes contained "instrumentos de científico" bound for an observatory, and saved my having to open the well-sealed boxes for them. Whew!

Before long, I was on another plane for the 500-kilometer flight north to La Serena, where the observatories are headquartered. My seatmate was Jerome Kristian, on the Las Campanas staff in Pasadena, who was arriving for a week-long run with the 2.5-meter DuPont telescope. He filled me in on various aspects of the observatory's operation and the state of Chilean politics. La Serena, a college-and-tourist town, was much cooler and noticeably drier than the capital. We were taken in an observatory van from the airport to El Piño, a hillside compound enclosing the administrative offices for both Cerro Tololo Inter-American Observatory (the U.S. national observatory's southern facility) and Las Campanas, operated by the Carnegie Institution of Washington. Jerry remained there overnight, but soon I was being taken to



The room with a view: the author's 6-inch refractor set up in the Las Campanas 25cm astrograph housing in the Chilean mountains, 17 February 1990. All non-astronomical photographs in this article are by Brian Skiff.

Following pages: The Las Campanas Observatory photographed from the DuPont telescope, 24 February 1990.

the mountain, more than two hours' drive north of the city along the Pan-American Highway.

The observatory lies along a steep-sloped ridge at the end of a 30-kilometer dirt road that turns off the highway. What a perch! Through mountain passes to the east one can see glaciers atop the highest peaks of the Andes. About 20 kilometers south, on another ridge, is the line of telescope domes on Cerro La Silla, operated by the European Southern Observatory. Each afternoon just before sunset, La Silla's phalanx of more than a dozen domes reflected the sunlight — glowing, as a friend says, like the noses on Santa's reindeer. To the west is a dramatic drop to a valley toward the coast ranges and the Pacific Ocean, which during my stay was always covered with a low-lying cloud deck. Every evening the sun set behind these clouds, which nevertheless lay below the horizontal by about half a degree.

After eating a dinner saved for me, I was assigned a comfortable hotel-like room. A hot shower and a change of clothes revived me enough to step outside for my first look at the southern sky. Oh. Oh! It was better than sex, folks.

I rushed back to the room for a planisphere and some charts showing bright stars and constellations. These were quickly dispensed with: after getting oriented and identifying a few of the brightest stars (four of the brightest stars in the sky were up: Sirius, Canopus, Rigil Kentaurus [a.k.a. Alpha Centauri], and Achernar), the southern sky has little to offer in terms of constellation patterns. These are replaced by discrete objects and the sheer brilliance of the far-southern Milky Way. I scanned for various objects for half an hour, but despite the splendor I finally got dizzy from fatigue and headed for bed, exhausted.

The next morning I set up the telescope on the floor of the 25cm astrograph building, a roll-off roof affair. Used by E. E. Barnard at Yerkes Observatory at the turn of the century, the astrograph's most recent claim to fame is the discovery of the LMC supernova on plates taken by Ian Shelton. It sat idle the three weeks I was there. My telescope's mount had a new clock-drive motor that ran "backwards" for the southern hemisphere, and which needed a 12-volt power source. The building is supplied only with North American 110v/60Hz power generated on the mountain and provided through either three-prong European or two-prong U.S.-style outlets. After a quick consultation, Oscar rigged up a spare 12-volt battery lying around. I aligned the mount by making the polar axle parallel to that of the astrograph mount and lining up the tripod legs with tiles on the linoleum floor, since the building was obviously erected toward true south. Later observation showed this to be entirely satisfactory for star-hopping and even for getting accurate position angles for objects near the south pole.

At dinner late that afternoon, I met the other "real" astronomers on the mountain. These included Bill Kunkel, one of the resident astronomers, and Laurent Drissen, a post-doctoral fellow working at the Space Telescope Science Institute in Maryland. Laurent had started the polarimetry with the Toronto 60cm, and would soon finish a three-week run that would overlap with his ladyfriend Carmelle, who would arrive in a few days. To these folks I made the first of my many explanations of what I was doing there: not "science," just looking through my telescope — purposefully, to be sure, but driven largely by aesthetic and even spiritual motives, seeking some kind of private knowledge about the World. Once people realized I really did astronomy for a living and knew what I was talking about technically, most accepted that I was legitimate, and were sometimes envious. "My hat's off to ya, buddy!" Kunkel exclaimed during our

first conversation.

Because of the many months that elapsed since first hatching the plan to go south, I had plenty of opportunity to plan an observing strategy. I selected several hundred objects of all types by consistent criteria and marked them on a copy of the "southern" volume 2 of *Uranometria 2000.0*. About 225 galaxies brighter than total B magnitude 13.0 were identified from the *Surface Photometry Catalogue of the ESO/Uppsala Galaxies* by Lauberts and Valentijn. In the region of four clusters of galaxies I picked those brighter than 14.0.

Open clusters were even more numerous in the available wedge of sky; I selected about 300, including those whose brightest stars are brighter than V magnitude 13.5. The austral late-summer sky holds few globulars, so they were only a small addition to the observing list.

Nebulae were another matter. Neither planetary nor diffuse nebulae have well-defined parameters like sizes and magnitudes published. The best I could do was to select all the planetaries that looked reasonably bright in the Perek & Kohoutek catalog and hope for the best. One reason for coming down here was to find out just which planetaries are accessible in amateur instruments; for many objects hardly anything is known beyond the position. For the diffuse reflection and emission nebulae, there is even less guidance in print. The only solution was to look at as many catalogued objects as possible and, again, hope for the best.

While the Moon was up, I planned to view double stars selected from the list in *Sky Catalogue 2000.0*, volume 2. Many of the bright naked-eye stars in the south are also close, interesting pairs — some of the most remarkable binaries in the sky. Alpha Crucis, for instance, consists of first- and third-magnitude stars just 3" apart!

As darkness came on the first night with the telescope, I felt sure that I would be disoriented. Everything is upside-down, right? Even the clock-drive is running backwards. Facing south, the stars were rising on the left and setting to the right. But as familiar constellations appeared, I found it easy to become accustomed to their patterns. Leo was rising in the east — on its back, indeed, but after a moment, it wasn't disorienting. Nearly on the meridian, high in the north, was Orion. At first glance it looked just as it does from the Northern Hemisphere: bright stars in the same corners, Belt stars at the same angle. But then I realized that Rigel was at the upper-left corner and Betelgeuse was the lower-right star. And the Belt stars were in reverse order. As I picked out other more northerly constellations, I immediately began mentally flipping patterns, like multiplying an equation by -1. The Hyades pointing down to the northwest, Aldebaran on top; Auriga low in the north, Capella at the base of the pattern, just rising out of the haze near the horizon.

But then I turned back to look up and then south. Wow! Sirius and Canis Major were familiar enough, albeit dead overhead from here. But the band of bright stars there continued with increased density along the Milky Way through Puppis, Vela, Carina, and Centaurus, which was just rising from under the south pole. The stars of Crux plus Alpha and Beta Centauri — including four zero-and first-magnitude stars — looked unnatural so bright yet so close to the horizon.

It was dark enough now for work. Reeling a little from the thrill of seeing this awesome sight, I had to stop a moment to "grok." I'm really in Chile with my little telescope! Although I knew that by now, of course, the southern sky is well-explored, I still felt like I was on the verge of striking out into that unknown territory on pre-Columbian maps with legends like "here be monsters."

There was still a bit of blue color in the twilight, so I started on double stars, picking off a half dozen before swinging to the first deep-sky objects: a group of run-of-the-mill galaxies in Volans. One continually needs reminders like these so that when the showpieces come along, you'll appreciate just how spectacular they are. The plan was to start at the South

Pole and work east and northward on successive nights, staying near the meridian and letting the sky bring the next batch of objects into view.

On the first several nights, deep-sky viewing would have to stop after a few hours due to Moonrise; it was a waning gibbous phase the first night, and rose only about 90 minutes after the end of twilight. But I needed to swing back onto a night schedule anyway after getting disrupted by the travel, and this is best done a step at a time.

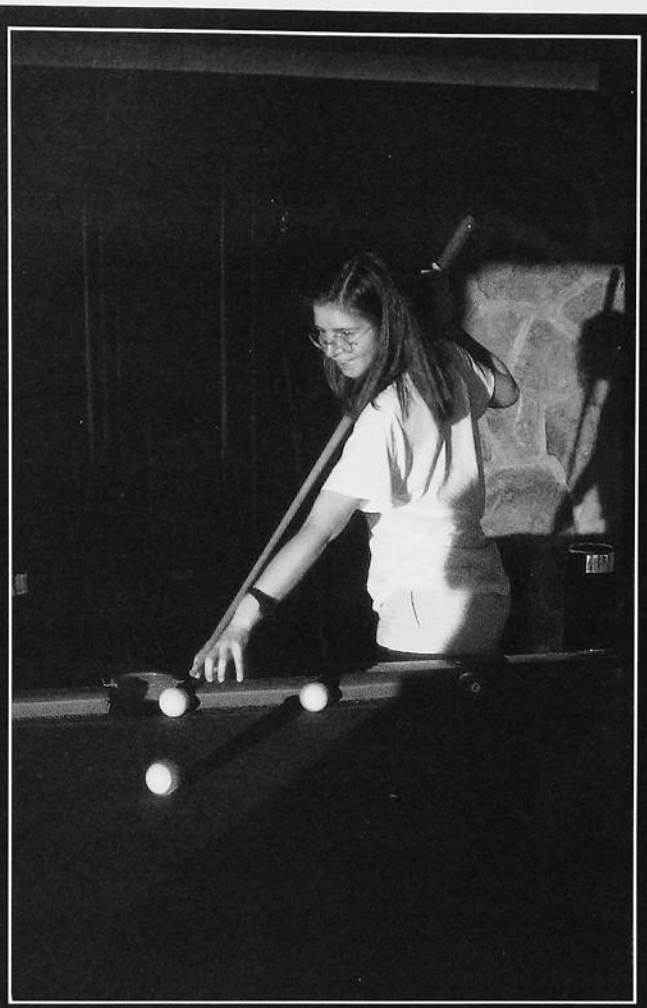
And so it went. Gradually the dark hours increased, and my count of deep-sky objects increased each night. There was an interruption after the first few nights — clouds! For about 36 hours the sky was pretty well covered with variably thick cirrus streaming down from Bolivia to the north; the Chilean staff called it "Bolivian winter." It was summer in Bolivia just as in Chile, naturally, but the weather pattern is similar to what they get in winter, which led to the name. (And, of course, everything bad comes from someplace else!) I observed double stars on the first of the two cirrusy nights, but on the second I hung around at the other telescopes to see what was up.

Las Campanas operates three telescopes: the DuPont 2.5-meter, an f/7 wide-field Cassegrainian; the Swope 1-meter, of similar design; and the University of Toronto 60cm. The telescopes were busy every night with a variety of instruments attached: CCDs for direct imaging and photometry of galaxies, infrared spectrograph being used to observe the atmosphere of Venus, and the "MINIPOL" photopolarimeter on the Toronto telescope, the busiest 60cm I've ever seen. Laurent and Carmelle collected photos every night from dusk to dawn for most of the three weeks I was there.

Days usually began at noon, when I would get up and eat lunch in the observatory dining room. Since only 12 or 15 people are on the mountain at any one time, this room is neither large nor fancy, but the picture windows provide views of unending interest. The Chilean menus featured some of the best beef in the world (Argentina probably claims the title), fish and shellfish, and since it was late in the summer, a wide selection of fresh fruit and produce. Grapes, melon, cantaloupe, papaya, peaches, strawberries, oranges, grapefruit and more were regular fare.

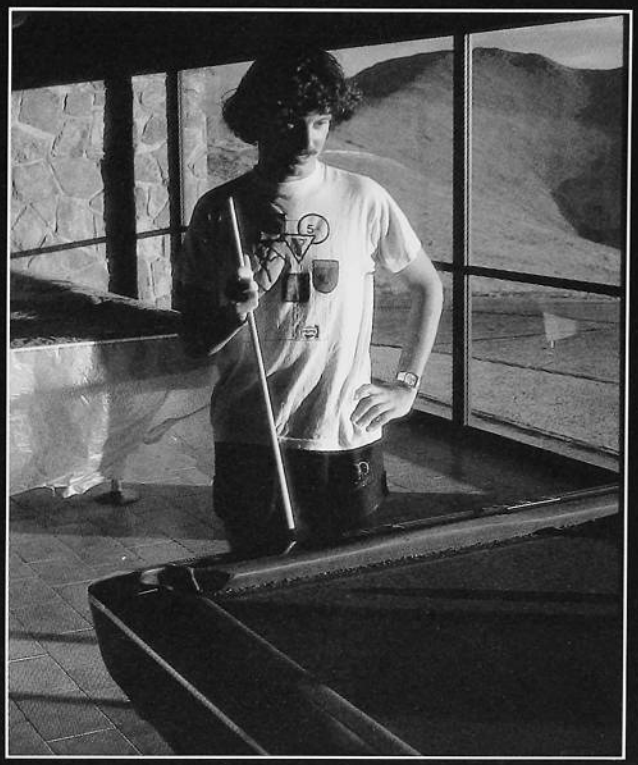
After lunch (breakfast, whatever) I would review the previous nights' notes. *Uranometria* charts that were completed were marked; then I noted the next night's starting chart for each zone of Declination in my logbook. The southernmost charts were dealt with in the first week, and I'd approached the brilliant region in eastern Carina. It would take parts of three nights to get through the riches here, including return visits to the Eta Carinae Nebula itself. Then I'd compare some of the observations against brief data sheets I'd brought. The central star in a certain planetary nebula was not visible even though someone's measured it to be bright enough for me to see. Did the nebula interfere, or is the data wrong? A faint globular cluster shows only a grainy texture; a list of the brightest stars in each cluster tells me this is about as expected since the member stars are at or a bit below my magnitude limit.

Occasionally, I would trek down to the DuPont dome, where the library is housed. Here I could find papers in the major journals with photographs of a nebula, say, or photometry of stars in an open cluster. A copy of the *ESO/Uppsala Catalogue of the ESO (B) Atlas* allowed me to identify galaxies I'd spotted near target objects that were not plotted on *Uranometria*. How much fainter was I going? That question had to wait until my return home, since there were no further references along that line. For some more northerly objects, I could verify details in the notes with the "Whiteoak Extension" of the *Palomar Observatory Sky Survey*. These were red-light photos covering from -30° to -45° declination taken in the early 1960s as a partial stop-gap until deep-sky surveys could be done from the southern hemisphere — something that didn't occur until about 1980. Sadly, neither of the re-



Faces at Las Campanas

Astronomers are people, too: Carmelle Robert relaxes with a game of pool before an observing run on 20 February 1990 (left). The opponent: astronomer Laurent Drissen (below). Who won? Only Brian Skiff knows for sure.



cent southern-sky surveys was on hand, of which I'd been warned beforehand.

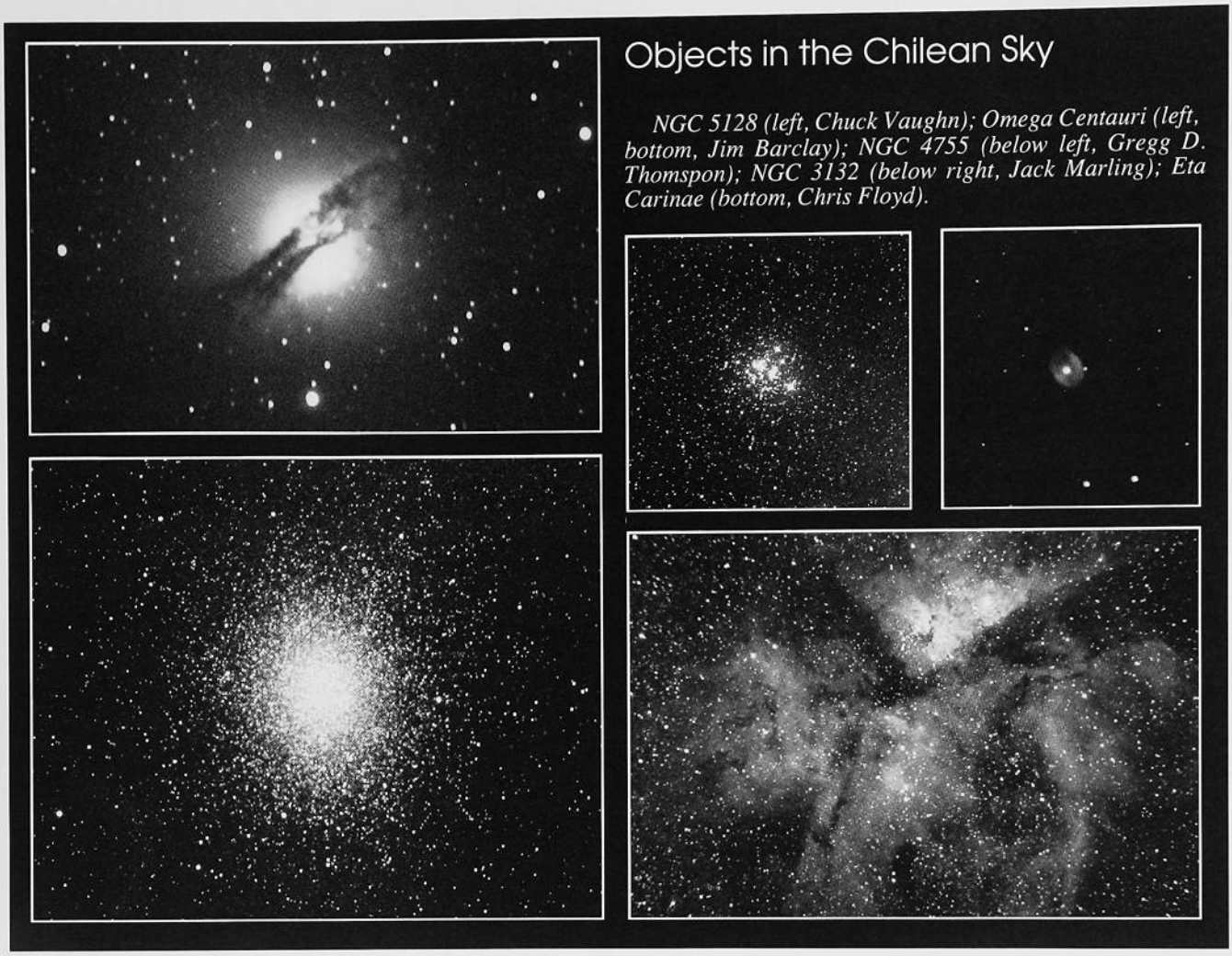
The 5-kilometer round-trip from the hotel to the DuPont and back served well to work up an appetite for dinner, which usually followed an afternoon nap. All the visitors would be there, and share conversations like Carmelle's and mine with Oscar. There would be discussion about the seeing, telescope performance and upcoming projects; complaints about equipment; and other a stronomical shoptalk. Dinner was accompanied every day by sunset over the coastal mountain ranges, a signal to the observers at the larger telescopes that it was time to head down and prepare for another night's work. Carmelle, Laurent, and I would muster our best Spanish to ask the cook for night-lunch: ham or chicken sandwiches, milk, orange juice, more fresh fruit, cookies — Laurent brazenly raided the kitchen storeroom for goodies. Fortified for the night, we'd then head off for observing.

Until this time each day, I tried to stay indoors or scrupulously wore a pair of very dark prescription sunglasses to preserve dark-adaptation as much as possible. A little-known consequence of prolonged exposure to bright sunlight is an increased threshold sensitivity upon subsequent dark-adaptation: you'll get dark-adapted, but the faintest things you can see will be as much as twice as bright as would be normal. That's three-fourths of a magnitude loss! It can take you a full night to get back to normal. Don't spend a sunny day at the beach or skiing and expect to do your best observing the following night.

But it was hard to stay inside all the time. There were vistas to take in with every change in lighting, tiny desert wildflowers to seek, soaring condors (okay, they were buzzards) to spot over the valleys, and hikes to take along the mountain ridge. And fresh air. This is a place where the air smells like nothing. No dust, no pollen, no organic odors, no pollutants: just clean air and onyx-blue sky. These attractions make the walk down to the telescopes each evening a delight: the long shadows throwing the landscape into stark relief, the deepening colors of the sky above the rock-strewn ridge, the exhilarating air, the prospect of yet another perfect night for observing.

Because the observing list was well laid out, I was able to observe much faster than I thought I could, having saved time through reduced star-hopping from target to target. Even without hurrying, I picked up about ten objects per hour, half again my usual rate. Most objects are near the telescope limit, and so could be adequately described in a couple of lines of heavily abbreviated and cryptic notes. Some objects, particularly the plethora of Milky Way open clusters, I skipped after noting merely that they were not of visual interest. One of my purposes here, after all, was to find out which are the good southern deep-sky objects. Only by being inclusive could I feel sure I hadn't skipped any hidden attractions.

One busy night was the 24th of February 1990. As was the case practically every night, the temperature at dusk was 54° F, where it remained for the rest of the night. Having already observed for a week, I had completed the southernmost areas that were on the meridian at dark, and so began with NGC 2427, a large galaxy in southern Puppis. I swept eastward into Vela, picking up the open clusters NGC 2660, Markari-



Objects in the Chilean Sky

NGC 5128 (left, Chuck Vaughn); Omega Centauri (left, bottom, Jim Barclay); NGC 4755 (below left, Gregg D. Thomspon); NGC 3132 (below right, Jack Marling); Eta Carinae (bottom, Chris Floyd).

an 18 and NGC 2849 while crossing the Milky Way. Toward Vela's eastern border and into Antlia the stars thin out again, and viewing switched almost immediately back to galaxies. Nearly touching the 12th-magnitude galaxy NGC 3263 was a very faint spot, NGC 3262, one of many companion galaxies I observed. Later I found it to have a total blue magnitude of 14.2, well below my survey brightness limit.

After I logged more than a dozen objects, including the bright planetary NGC 3132 and the globular NGC 3201, the more southerly fields had risen. I jumped down to about -65° declination and picked up where I'd left off the previous night in Crux and Musca. This sweep included several more planetary nebulae, such as IC 4191, PK 307-4°1, and the southern sky's most interesting object in this class, NGC 5189. Continuing east, I surveyed objects in Circinus, an overlooked southern constellation, which includes the brilliant half-arcsecond double star Gamma Circini as one of the highlights. Because of the always-perfect seeing, I saw the two merged Airy disks and diffraction rings at 410x looking like a textbook illustration of an unresolved double star. More planetaries here, too: NGC 5315, PK 309-4°1 (not visible) and PK 310-2°1, a 14th-magnitude object that was brought forth from invisibility by a nebula filter. And one more galaxy, ESO 97-G13, right in the thick of the Milky Way.

At the southeastern corner of my survey area, the relatively dull constellation of Apus held a mix of objects, among them the galaxy NGC 5967, the faint planetary PK 308-12°1, and two partially resolved globulars: NGC 6101 and IC 4499, the southernmost globular in the sky. Finally, I finished up with a few objects farther north in Centaurus and Triangulum Australe. By now it was past 6 a.m., and I'd logged over eighty objects. With dawn breaking over the Andes, I walked back to the lodge exhausted but elated.

A day or two after that busy night, Oscar Duhalde returned from his off-duty week away from the mountain. An important anniversary has passed, he said, and nobody noticed: the 24th marked three years since the eruption of SN 1987A!

At this rate, my logbook filled up quickly. Most nights I found that after bagging fifty or sixty objects on a single night I ran out of steam. It was not merely that I was sleepy, and there was usually an hour or two before dawn broke. But upon centering yet another faint fuzzy in the eyepiece, I'd just stare blankly, and there seemed to be no words to describe this object and make it seem at least a little different from its neighbors.

What to do? If it's not fun, then blow it off! I closed the logbook, put in a low-power eyepiece, and headed off for the real showpieces. Eta Carinae (again), Omega Centauri (again), NGC 5128, NGC 6067, the Kappa Crucis "Jewel-box" cluster, NGC 2516, and other naked-eye objects would pass quickly into the field of view. Even though they were still rising in the east, I took tours through Scorpius and Sagittarius, whetting my appetite for another trip. □

Brian Skiff is an astronomer at Lowell Observatory, coauthor of Observing Handbook and Catalogue of Deep-Sky Objects *(Cambridge, 1990), and senior contributing editor of this magazine.*

The Magic of Unsharp Masking

Discover easy techniques that will unlock the details in your astronomical photographs and amaze your astrophoto buddies.

by Chris Schur

Shooting the sky with modern, hypered, fine-grained films is an exciting pastime for many astrophotographers. The combination of excellent emulsion characteristics and ease of processing makes films like Tech Pan an ideal choice for producing rewarding results. Printing black and white negatives with these contrasty films, however, can be a compromise situation. The best and brightest deep-sky objects contain both faint and bright regions. Typical examples are the Lagoon and Trifid nebulae, the Orion Nebula and the Andromeda Galaxy. The problem facing home darkroom technicians is that today's printing papers do not have the dynamic range to be able to reproduce the brightness ranges available from these emulsions.

There is a remedy. By using the techniques of unsharp masking for printmaking, we can reproduce much of the detail in the negative and explore the densest and most overexposed regions of a nebula while retaining nearly all of the faint outer nebulosity present in the negative.

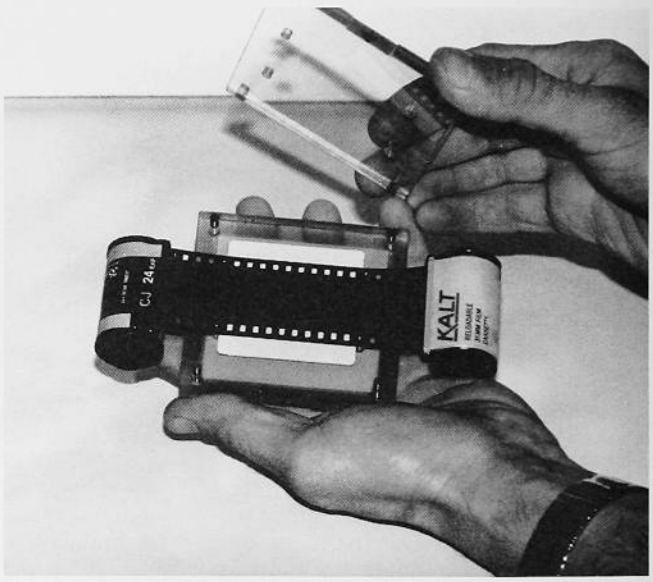
Most astronomical photographs are produced on high contrast emulsions, making faint and low contrast details easily visible. Because of this, in a deep exposure the densest portions of a bright nebula can be up to ten thousand times darker on the negative than the faintest wisps recorded. Since photographic printing paper can only handle normal densities consisting of perhaps a hundred gray shades from black to white, a compromise must be reached in the printing process. You have the option of printing for high contrast, and getting all of the faint outer nebular details, while at the same time burning in most of the central regions pure white. On the other hand, if you print for low contrast, about half of the brightest regions will show some detail, but you will lose all of the outer nebulosity.

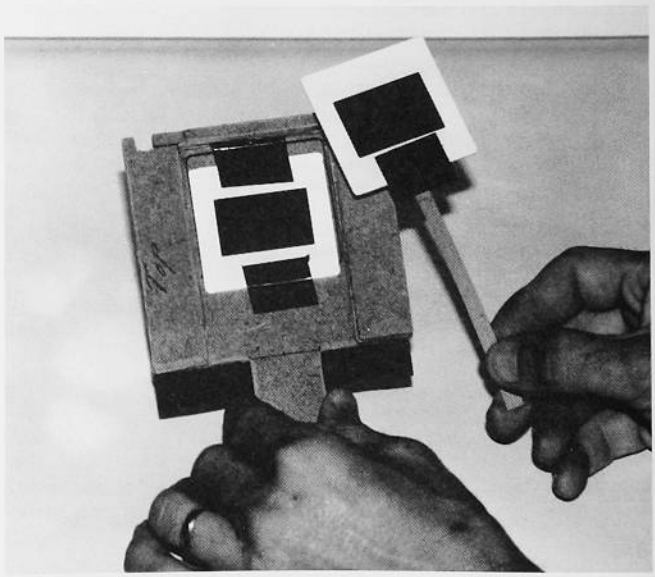
How then can we print our astronomical negative in high contrast to show all of the outer nebulosity, yet retain as much as possible of the densest regions — all in one print?

Welcome to Unsharp Masking

The answer lies in a relatively simple technique, first applied extensively in astronomical photography by David Malin in 1977 to explore the wealth of details in deep southern Schmidt camera plates. The concept was fairly straightforward. He made a mask to print the negative through to add more light into the densest, innermost parts of the nebula without affecting much of the outer dim nebulosity or any of the fine details within the nebula.

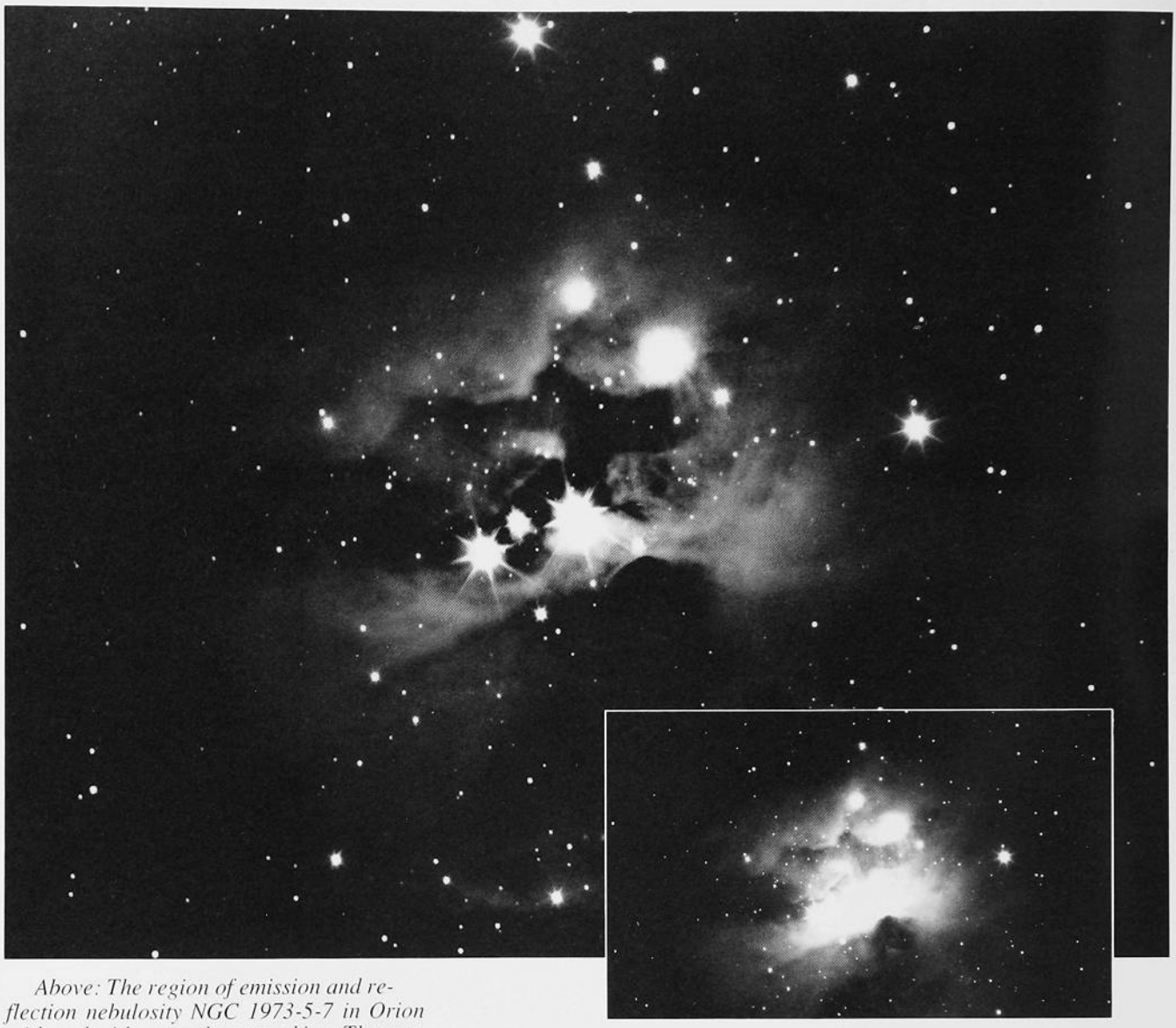
To make such a mask, Malin produced a contact print of the original negative and exposed it onto low contrast film





Top: Apparatus to make the unsharp masks. Above: Unsharp mask and enlarger carrier. Opposite page: Unsharp masked photo of M31 by Paul Lind (8-inch f/4.5 reflector, hypered Tech Pan film, 50-minute exposure).

A Portfolio of Unsharp Masked Photographs

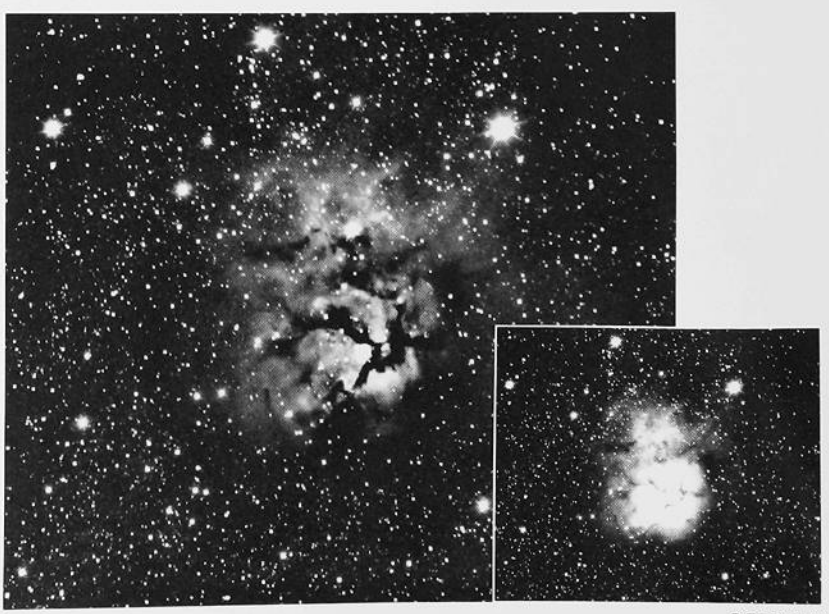


Above: The region of emission and reflection nebulosity NGC 1973-5-7 in Orion with and without unsharp masking. The negative was made with a 14-inch f/5 reflector, hypered Tech Pan, and a 45-minute exposure. An unsharp masked print shows inner detail; the normal print (inset) is overexposed in the central region.

Right: A 45-minute exposure of the Trifid Nebula with the same setup produces similar results. The unsharp masked version retains inner detail lost in the straight print (inset).

Opposite page: A dramatic difference is visible in photographs of the Lagoon Nebula, made with the same setup and a 45-minute exposure.

All photographs on this spread and the equipment photos on the previous page are by Chris Schur.



This photograph by Chris Schur is a straight print of the Omega Nebula in Sagittarius. While an extraordinary image by any astrophotographer's standards, the 45-minute exposure (14-inch f/5 reflector, hypered Tech Pan film) has even more potential.

with a very diffuse light source and a thin transparent spacer between the negative and copy film. The result produced a blurry positive which contained all of the coarse information found in the negative — in the form of brightness information — but no fine details. When this weak positive mask is sandwiched with the original, the two nearly cancel out. What is left was a very much lower contrast (and very dark) negative image that contains a lesser range of densities. But also present is all of the original fine detail.

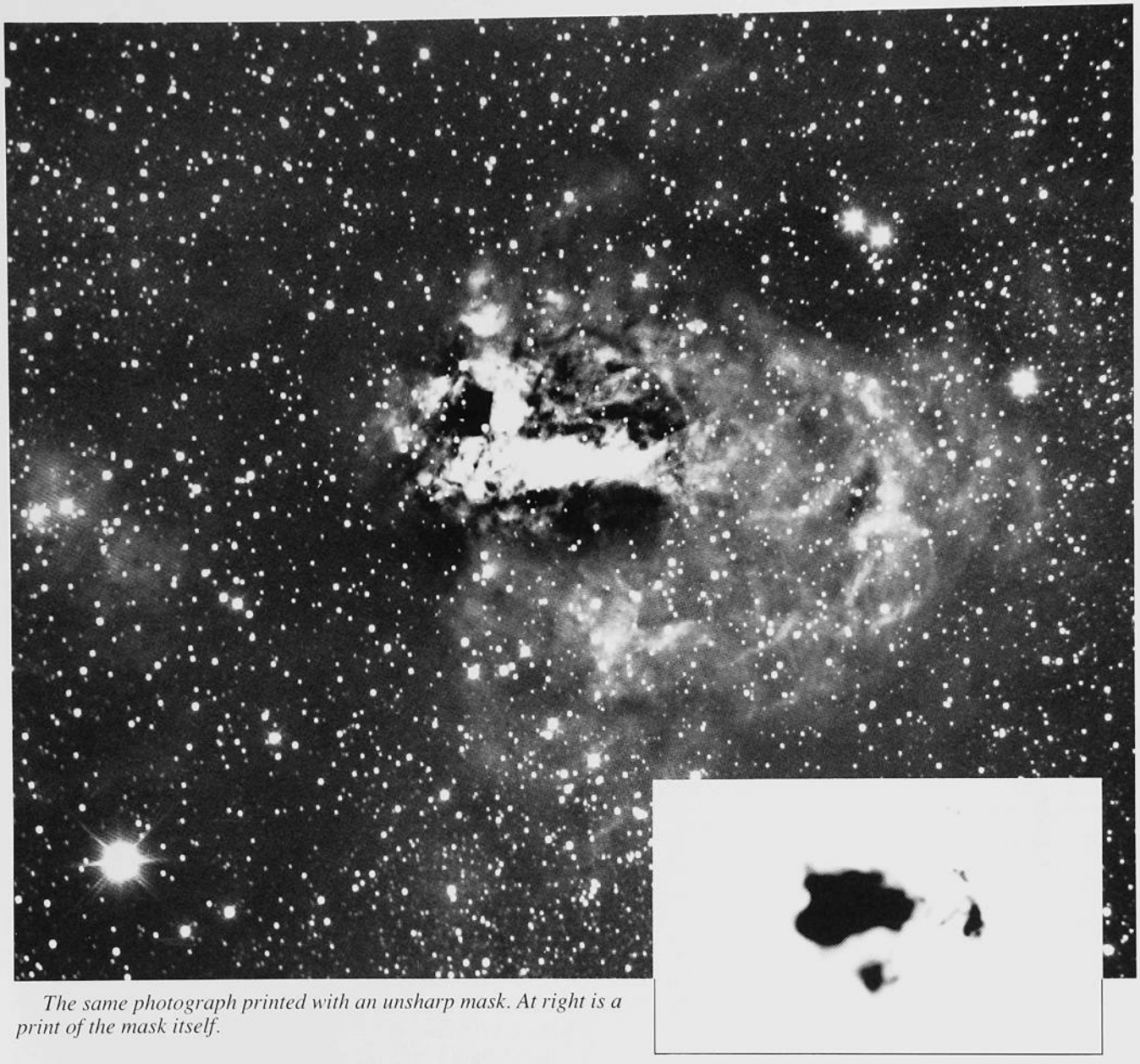
It's possible with this technique to produce prints that reveal details deep within the bright core of a nebula and pick out structures that are normally hidden. However, in practice, printing such a negative is impractical with standard equipment because the negatives are quite dark, so I have modified the procedure to use common enlargers and normal high contrast printing papers.

Making an Unsharp Mask

To make a series of masks for printing, use a homemade Plexiglas fixture, a roll of regular Technical Pan emulsion that will be developed for high contrast, and an empty film cassette. Using the empty cassette as a take-up spool, stretch the film across the fixture (in total darkness!), and insert the negative in a standard slide mount and lay it on top. The thickness of the slide mount prevents direct contact of the negative and film. Next, place a Plexiglas cover 3/8" thick on top with a diffuser of thin paper covering the fixture. Make various exposures using the stopped-down enlarger as a light source. Advance the film after each exposure by stretching fresh film over the negative and using the blank cassette as a take-up spool. The exposures should range from 1/2 to 10 seconds in duration. When the film is developed in D-19 developer, a whole strip of assorted density blurry positives are available for masking.

To make an unsharp masked print, first load the mask into a separate slide mount. Then place the negative into the enlarger's negative carrier. The negative must be on the bottom and taped down securely on the edges so it will not move during the printing process. Tape a small wooden stick to the top of the mask's slide mount so you can pull it out. Then stack the mask in register with the negative.

With the enlarger's aperture open all the way for maximum brightness, make an exposure that lasts anywhere from 30 seconds to several minutes. The full brightness is required for very dense objects so that maximum light burns properly



The same photograph printed with an unsharp mask. At right is a print of the mask itself.

in the center of the object. Then carefully slide the mask out by pulling on the wooden stick, and stop-down the lens one to three stops.

Now make a normal short exposure without the mask to print the sky background and the faintest portions of the nebula. This modified procedure using a high contrast mask prevents the jet-black outer portions of the mask from shining light on the photographic paper, leaving the outer nebulosity untouched, yet can allow up to ten thousand times more light to reach the brightest parts of even the most complex objects. It doesn't matter where the bright parts are in the object — the mask will allow extra light to reach these areas for a more complete exposure.

The goal of such efforts is to produce a perfect medium dark gray background sky all around the object using your highest contrast papers, yet reduce the size of the highly exposed featureless white regions to a minimum.

Several comparison shots are included here to demonstrate the dramatic affect of this simple procedure. The 45-minute exposure on hypered 2415 film in this article was taken with my 14-inch f/5 Newtonian, printed on Kodak Polycontrast RC paper, and filtered for maximum contrast. The print made without the mask contains only a huge nearly featureless white shape, with clear details only around the edges. In the masked print, the entire nebula is covered with dark globules, wreath-like structures, and dark lanes. This method is powerful for showing the true details of the inner regions of bright nebulae while retaining the perspective of the whole object in one print.

Unsharp masking may allow us for the first time to see the hidden detail that lies within most astronomical photographs. The modified procedure we use that is presented here is simple enough so that even the most basic darkroom can turn out spectacular masked prints, with a minimum of cost and only modest effort. This opens up an entirely new realm of opportunities which has only recently been exploited by professional observatories. □

Astrophotographer Chris Schur is recognized as one of the leading practitioners of his craft in the world. His photos appear frequently in the major astronomy magazines.

The Splendor of the Milky Way

Take a photographic journey through the expansive vistas of our home Galaxy.

by David J. Eicher

The Lagoon . . . The Trifid . . . The Bug . . . The Eagle . . . The Omega. It's summertime again and I've got all of those funny names banging around in my head. Can't get 'em out. It's okay, though, because I'm gonna go out and look at some of those faint fuzzies tonight anyway. That is, if the rain holds and the cirrus clears away. It's a funny thing, the sky — you can't count on it clearing off for you, yet there's no other game in town. It's both friend and enemy in the relentless pursuit of a dark blue window into the universe.

Before twilight approaches, though, I need to check the equipment and get it ready for another season. Did the scope survive the garage during a northern winter? Yup — looks alright, despite the fact that I still have to tighten up the focuser (something I didn't do during any of the last two years). As I walk over to the legendary toolbox, I shudder at the layer of soot that coats it. It's a dark creaky corner of the basement that makes itself home for the astro equipment, and getting it ready for mainline observing each year is like reaching into a partly forgotten universe. Inside the box everything is still in good order, despite the fact that again this year the first thing to spring into my head is "How come I haven't used half of this stuff in more than five years yet I still firmly believe I need it?"

I walk upstairs and into the back yard, up the hill and back to the tree line. The sky is getting dark — the time to set up has come. It's back into the house, however, to quickly scan my copies of Tirion's *Sky Atlas 2000.0* and *Uranometria 2000.0* for some pet objects to hit during the first hours of observing. I scratch together a list and, fueled by adrenaline because I'm running out of time before dark, head upstairs to drag the telescopes outside.

Tonight I'll go all the way to initiate the warm season's observing. Rather than take a single scope, I'll haul out the 17.5-inch Coulter, the 8-inch SCT, the Astroscan, and a 3-inch refractor. It's time to kick things off right. It's time to do a little comparative observing of faint objects. It's time to see what can be seen in the small scopes. As General Schwartzkopf would say, it's time to kick butt.

The scopes are ready and cooling, and the sky looks like it just might cooperate. Time to waltz back to the house for one last gathering of materials before coming outside and initiating the dark-adaption process. (Read: Time to scarf down three brownies, half a bag of Fritos, and a can of Coke in time to generate some calories.)

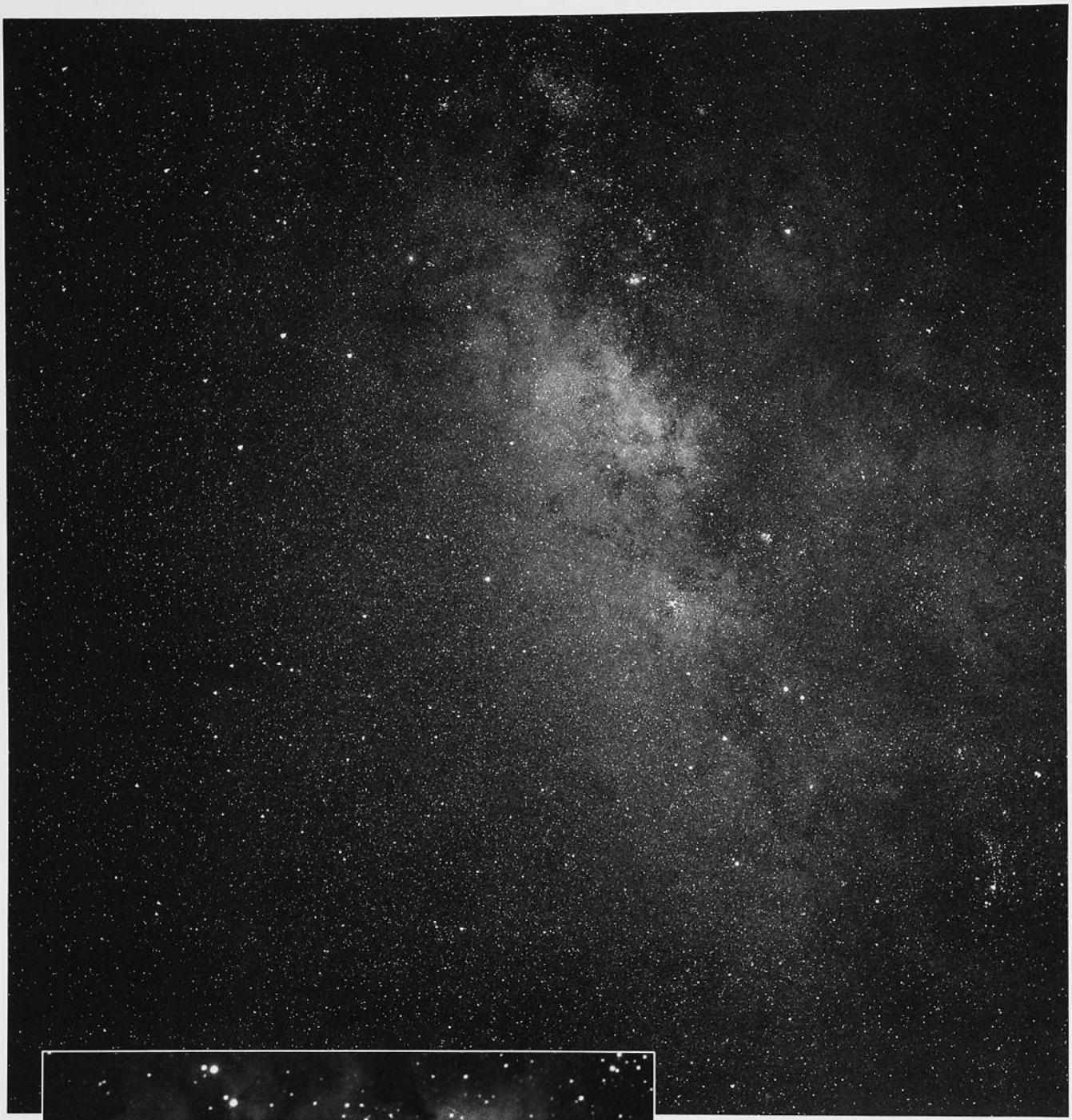
I stretch, limber up, and play the last two minutes of the first episode of Cosmos on the VCR. (After all, this is the ultraspectacular first of the season warm-up!) I walk up and down the stairs to start building up heat. I walk into the bathroom, look myself in the mirror, and recite the names of the first sixty-five NGC objects I'm going to hunt tonight. Then I recite them all twice as fast, backwards. I stop, look at my face for a moment, and think that either this is *serious* observing or else I'm completely out of my mind. Or both.

I walk downstairs, kiss my wife, and head out the door. Then it hits me, as I reel in silent torture, spinning around the driveway like someone who has been shot through the back with an M16 (the assault rifle, not the emission nebula). Time has frozen: it's like the opening lines of a bad foreign film where the credits just keep coming forever.

The sky is completely cloudy. I've been had.

I walk inside and sit motionless on the couch in a vegetative stupor. My first night of great observing shot down in flames! And by what? A bunch of water vapor? What a wimpy nemesis!

Then I regain control. I figure I can wait another night. After all, tomorrow *is* another day. □

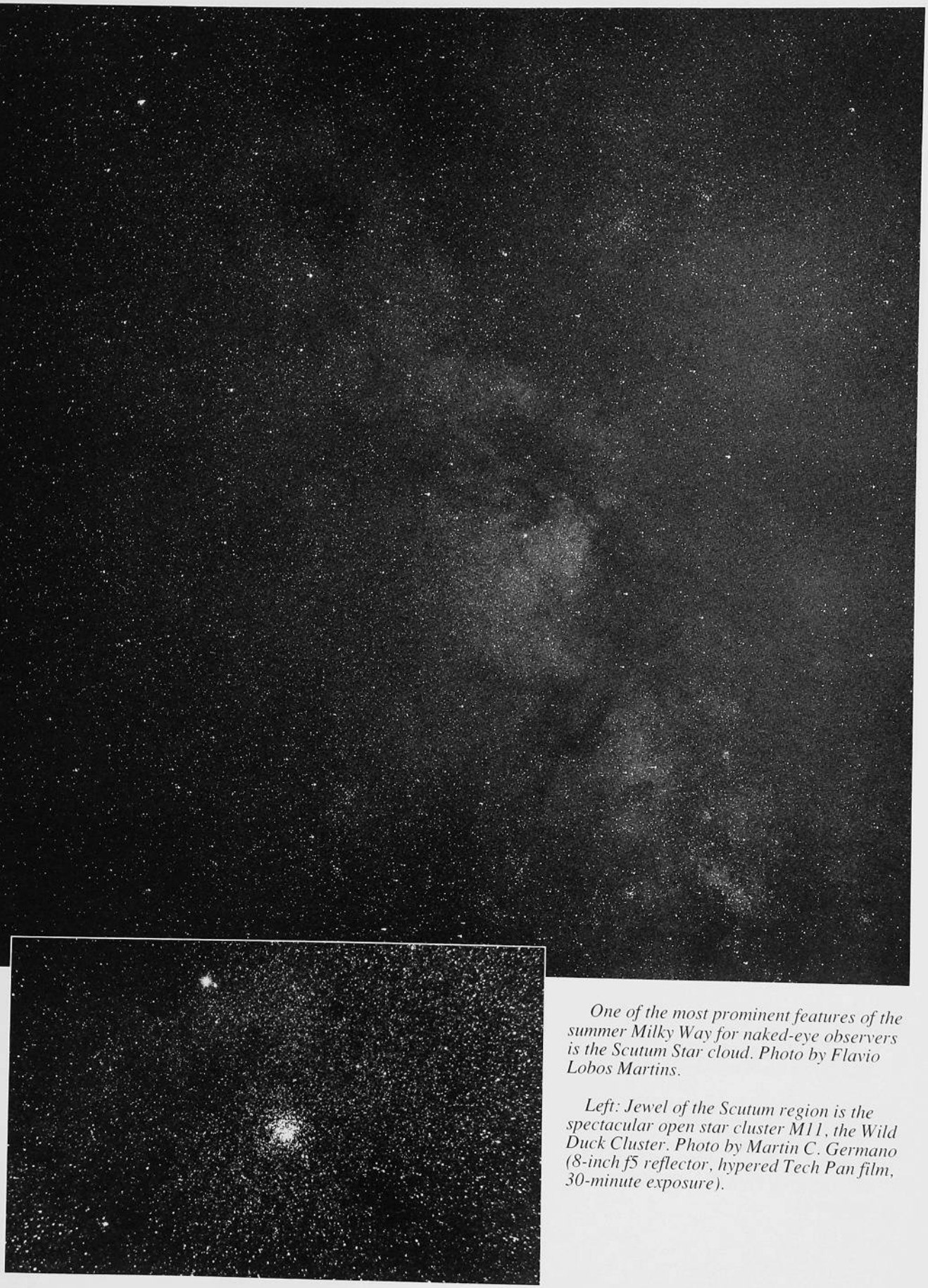


The Sagittarius region is studded with numerous deep-sky objects. Photo by Flavio Lobos Martins.

Left: One of the great gems of the Sagittarius region is the Trifid Nebula, M20. This spectacular image from Kim Zussman (14.5-inch Cassegrain telescope at f/8, hypered Tech Pan film, 60-minute exposure) shows the inner region of the Trifid and its central, double star.

Moving south along the plane of the Milky Way, we come to Scorpius. Also home to numerous deep-sky objects, Scorpius is a favorite of many low-latitude observers.

Right: NGC 6302, the Bug Nebula, is one of the most peculiar bright planetaries in the sky. Its odd form is easily visible in moderate aperture telescopes. Photo by Martin C. Germano (8-inch f/10 SCT, hypered Tech Pan film, 45-minute exposure).

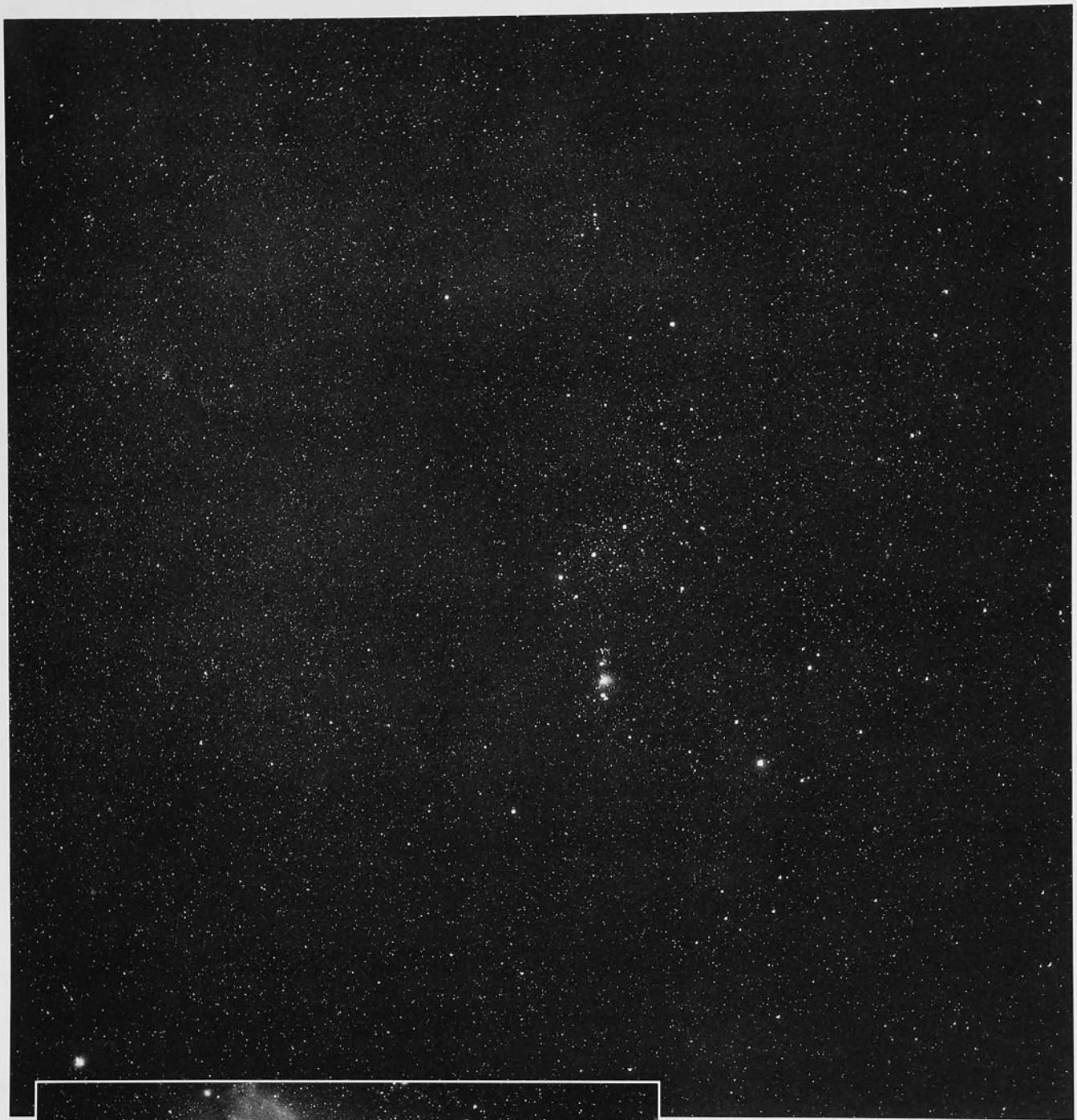


One of the most prominent features of the summer Milky Way for naked-eye observers is the Scutum Star cloud. Photo by Flavio Lobos Martins.

Left: Jewel of the Scutum region is the spectacular open star cluster M11, the Wild Duck Cluster. Photo by Martin C. Germano (8-inch f5 reflector, hypered Tech Pan film, 30-minute exposure).

The great "V" shape of the bright stars in Aquila is unmistakable on summertime evenings. Photo by Flavio Lobos Martins.

Right: The most challenging object in Aquila for small scopes is the low surface brightness planetary NGC 6781. Photo by Kim Zussman (modified 11-inch f/10 SCT, hypered Tech Pan film, 100-minute exposure).



Visible again in the early morning during late summer, majestic Orion offers sights that seem strange seen outside of winter. Photo by Flavio Lobos Martins.

Left: The Horsehead Nebula, B33, is one of the most challenging dark nebulae in the sky. Photo by Bruce D. MacDonald (12-inch f/5 AstroMak, hypered Tech Pan film, 120-minute exposure).

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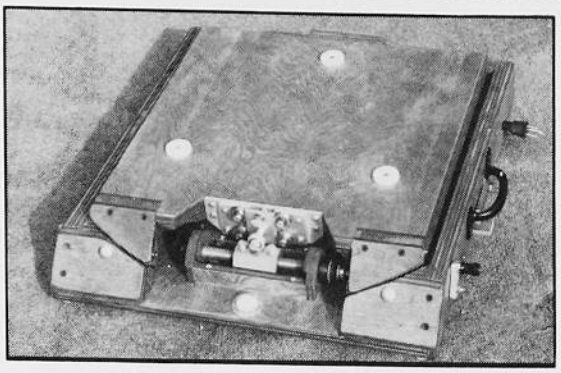

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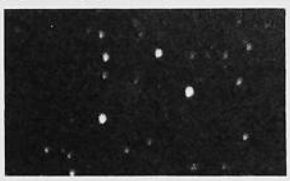
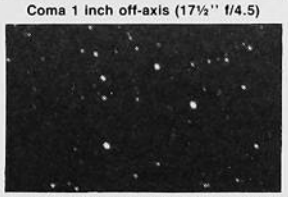


Coma 1 inch off-axis (17½" f/4.5)



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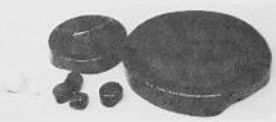

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Deep Sky Reports

Treasures of the Core

by Tom Johnston

When I drive 730 miles to find the proper observing location I usually have a definite observing plan, so as not to waste precious time. And when the observing location is Luna Lake, Arizona, that time is very precious. On a recent excursion there, one such project was to observe objects along the galactic equator that were shown in volume 2 of *Uranometria 2000.0*. I was equipped with an 8-inch reflector.

The clear and incredibly dark skies found at the Lake enabled me to track down almost every one of them, the notable exceptions being the tiny, faint planetary nebulae carrying the PK (Perek-Kohoutek) designation, which tend to be out of my reach. I also stayed within 3° or 4° of the equator, mostly to the southeast. This area rises high in the southern sky from Luna Lake and contains just about every kind of object available, except galaxies.

This observing project also represented my first serious approach to a particular class of object I had admired on my last trip — dark nebulae. They're all over this area of the sky, small ones and large ones. Most of them are very well defined and easy to spot, especially those lying in rich areas of the Milky Way. A few even appeared to have turned edges, like the edges of very dark thunderclouds. Some of these objects lie within other, larger dark nebulae. More difficult to see are many small bright nebulae. While some of them presented no problem, others were quite faint and often washed out by stars involved with the nebulosity or simply lying nearby. Close, bright stars also hampered the views of some of the large bright nebulae, but not so much as to obscure them from sight. Equally elusive are the faint open clusters with the Bas, Bo or Do designations, which often look no richer than the background Milky Way.

Half of the time spent during three nights of observing at Luna Lake went into the following notes. The other half was taken up by another project concerning the main Coma-Virgo supercluster of galaxies.

There is no better starting place than the **Lagoon Nebula**, M8 (NGC 6523). Its vast expanses of glowing gas and dust contain a bright open cluster, a bright multiple star system and several dark lanes and intrusions. On the way

The faint nebulae IC 1283, NGC 6595, NGC 6589, and NGC 6590 photographed by Chuck Vaughn (14-inch SCT at f/7, hypered Tech Pan film, 60-minute exposure).

to the Trifid Nebula you'll find **Bochum 14**, a very small collection of very faint stars, and **NGC 6526**, a faint but easy-to-see nebula that surrounds several stars. NGC 6526 really stood out in my 7x50 binoculars. Then, of course, there is the **Trifid Nebula** itself, M20 (NGC 6514). **B85**, the dark lane that gives this object its unique appearance, has a structured, wispy look as it snakes through the nebula. Nearby lies **M21**, a relatively small, slightly irregular shaped open cluster with some 15 to 20 bright members.

Moving southeast, we encounter **NGC 6546**, a faint group with a bright conspicuous triangle at one end. Next is **IC 4684**, a faint reflection nebula surrounding a 9th-magnitude star. Averted vision always helps when trying for these objects. In the glare of 11 Sagittarii lies a broad, faint nebula known best as **NGC 6559**, but also including fainter sections catalogued as **IC 1275**, **IC 1274**, and **IC 4654**. The three IC objects appear as slightly condensed or brighter areas of the main glow. At the north end of IC 1275 is **B91**, a dark patch slightly larger than its hole-like counterpart **B303**, located near a bright star at the southern end of NGC 6559. As with some of the other PK planetaries, I found a very faint, non-stellar object at the general location of **PK 6-2.1**, next to a faint comparison star, but could not confirm its identity.

Another possible sighting came with a very small, faint, round, hazy spot at the location of **Terzian 11**, an obscure globular cluster, but I suspect this one was a case of wishful viewing. Moving northward, we encounter the small and faint cluster **NGC 6563** and its larger companion **NGC 6568**. NGC 6568 appears to have some dark lanes to go along with the H-shaped string of brighter stars across its face. Farther northward we find the stellar planetary **NGC 6578**, a faint, gray object that needed 212x to show up well. Surrounding two stars near 16 Sagittarii is **Sharpless 2-35**, a faint glow with one apparently brighter portion. North of here is the open cluster **NGC 6595**. The nebulae **NGC 6589** and **NGC 6590** appear as bright, nebulous spots intermingled with this cluster. In the same field is the faint, nebulous cloud designated **IC 1283-84**. A low power (48x) field gave a beautiful view of the cluster and four nebulae together.

Few areas of the sky are as densely star-filled as that occupied by **M24**, the Small Sagittarius Star Cloud. This huge, easy naked eye glow resolves into thousands of stars, even in the smallest of telescopes. Near the southwestern edge of the cloud is the stellar planetary **NGC 6567**. This object required 212x for positive identification. The cloud's northern half contains the obvious condensation **NGC 6603**, an oval-shaped group of hazy stars. Along the northern edge of the cloud lie the well documented dark nebulae, **B92** and **B93**. These are the best examples of dark nebulae available to northern observers.

Continuing northward from the cloud will bring into view **M18** (NGC 6613). This compact cluster is quite bright, with about 15 promiment members. Northwest of M18 is **NGC 6596**, a slightly larger, loose cluster of some 40 members. Moving a degree northeast of here brings one of the galaxies' most beautiful sights into the eyepiece, the Swan Nebula, **M17** (NGC 6618). Since you've probably seen this object a million times by now I won't use up the four or five pages it would take to adequately describe the Swan. This nebula has a very faint companion that appears as a glow surrounding a double star a few arcminutes west of the Swan.

About 2° north of the Swan lies its feathered friend, the Eagle Nebula, **M16** (NGC 6611). The sprawling nebula is dominated by a bright, tight open cluster. The dark skies of Luna gave both the Eagle and the Swan appearances I have never seen from my usual observing haunts in Colorado. About 3° west of the Eagle is the very faint nebula **Sharpless 2-46**, which surrounds a small group of stars. Averted vision is a must for this one.

A few degrees southeast of the Eagle is the faint cluster designated **Dolidze 28**. Only a few stars are resolved in this otherwise hazy object, including a single bright star on the western edge. Northeast of the Eagle is the small, faint nebula **Sharpless 2-53**, another averted vision object. Slightly farther north is the somewhat elongated open cluster **NGC 6631**, possessing many faint members. In the same field is the well-defined, pear-shaped dark nebula **B95**. On the other side of B95 is the huge, irregular-shaped, faint nebula **Sharpless 2-54**, whose edges were quite distinct. Deep in the main glow is the tight open cluster **NGC 6604**, a group of about 10 members dominated by a bright yellow star. If you back up to **Sharpless 2-53** and move 1° east you'll notice **NGC 6639**, a hazy cluster with about 10 members. Moving the same distance north again shows the fairly easy, loose cluster **Ruprecht 141**, a group of some 15 members with one bright star near the center. Less than 1° north of here is the tough **Sharpless 2-55**, a very faint glow surrounding a few stars. I checked the locations of **PK 20-0.1** and **PK 21-1.1** but found nothing.

Proceeding further up the galactic equator brings us to **IC 1287**, another tough glow surrounding a bright yellow-blue double star. Near here lies **NGC 6649**, a small, condensed open cluster, with a bright edge star, that almost looks like a loose globular cluster. One degree northwest is the large, well-defined dark nebula **B97**. Just up the equator from here is a pair of dark nebulae, **B100** and **B101**, which are both pear-shaped and easy to see. From Luna these many dark nebulae weren't just areas without stars, but rather obvious 3-D clouds of black dust, obscuring stars behind them and highlighting stars in front of them. **B314**, another dark nebula about 1° southeast of B100 and B101, is obviously bulbous at one end.

Dark nebula B103 photographed by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 50-minute exposure).

Sliding up to Alpha Scuti will show the ovalish open cluster **NGC 6664** in the same field. This a good warm-up for viewing **Trumpler 34**, a smaller, much fainter group of about 10 stars 1° east of NGC 6664. Just over 1° north of Alpha Scuti is an arc of three faint, large clusters. All three — **Dolidze 29**, **Dolidze 30**, and **Dolidze 31** — contain many faint members and appear hazy in the eyepiece. (Clusters like these would be invisible from my observing site in Hudson, Colorado!)

B103 is a large, very opaque, irregular dark nebula lying along the edge of a condensed area of the Milky Way. Embedded in that condensed area is the open cluster **NGC 6683**, small and compact. Dropping three degrees due south and a bit east will snap **M26** (NGC 6694) into view. M26 is fairly small, bright, and slightly oval in shape. Moving eastward a few degrees brings us to the slightly oval globular cluster **NGC 6712**, its even glow showing minimal resolution. Only a half degree away sits a good challenge for a small scope, the planetary nebula **IC 1295**. This soft, slightly oval glow looks a little brighter than the 14th magnitude I've seen listed for it. It's puff of smoke amongst the myriad of background stars.

Moving northward once again brings you to a series of seven dark nebulae that eventually lead to the stunning **Wild Duck Cluster**, M11 (NGC 6705). **B118**, **B117**, **B116** and **B114** are easy-to-see patches that work their way around several faint stars. **B115** was very obvious and seemed much longer than the "box" shown on *Uranometria*. **B112** was also easy and well defined. **B318** was especially interesting to observe: a long, skinny line of black with a knob of darkness, **B108**, at one end. M11 is dominated by a beautiful bright blue star in the center of a well-resolved group of about 100 stars. Just over a half degree northwest of M11, between two bright stars, is the small and faint cluster **Basel 1**. It appears to consist of an arc of four or five faint stars and some hazy background glow. There are two very nice double stars between Basel 1 and M11, one yellow-blue and the other orange-blue.

A degree north of Basel 1 lies Beta Scuti. Just north of Beta lies the wonderful dark nebula **B104**. East of Beta lies the large dark complex known collectively as **B111** and **B320**. Embedded in it you'll find **NGC 6704**, a small, bright open cluster with a soft background glow. **B110** and **B113** look like two completely void pits in an already dark pool of dust. **B117a** and **B119a** are also of the sprawling variety and appear to be separated by three faint stars. Just over 1° west of Beta lie **Trumpler 35** and **Dolidze 32**. Both are faint and look much like condensed portions of the Milky Way.

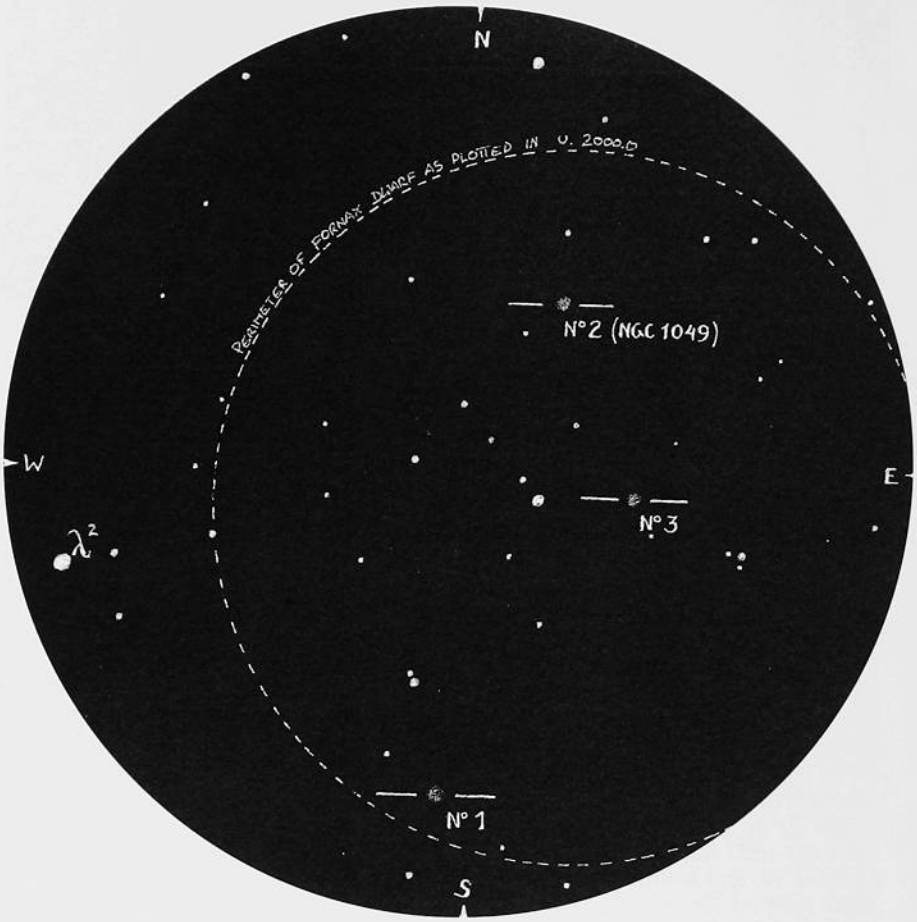
With most of these objects within one field of view away from each other, star-hopping, or object-hopping in this case, becomes an easy, even delightful task. So you don't have to wait for a trip to your own particular "heaven on Earth" observing spot to try this list. But if you must, turn west at Socorro! □

Tom Johnston is an avid observer living in Boulder, Colorado. This is his first article for Deep Sky.

Deep Sky Reports

...And Now for Something Completely Different

by Gerd Bahr-Vollrath



A low-power sketch of the Fornax Dwarf Galaxy (made with an 8-inch f/10 SCT at 45x) shows three globular clusters.

Opposite page, top: Globular Number 1 appears as a faint ball of light set in a starry field. Sketch made with an 8-inch f/10 SCT at 80x.

Opposite page, bottom left: Globular Number 2, NGC 1049, is a relatively bright and easily visible object. Sketch made with an 8-inch f/10 SCT at 80x.

Opposite page, bottom right: Globular Number 3 as viewed with an 8-inch f/10 SCT at 80x. This cluster is fainter and the field much poorer than the view of NGC 1049.

The inconspicuous constellation Fornax is well known among seasoned deep-sky enthusiasts as a hunting ground for galaxies, but how many of you have learned to appreciate Fornax for its three globular clusters? One globular, NGC 1049, is widely presented in the literature, but two more virtually in the same low power field of view seem to have managed to be avoided in all sorts of catalogs. In fact, I could not even find an identification for them. These globular clusters are members of the Fornax Dwarf Galaxy, a small Local Group member lying at a distance of 140 kiloparsecs. The Fornax Dwarf is the brightest and largest of the eight known dwarfs that are associated with our Galaxy — and the only one to contain globular clusters.

One night I wanted to treat myself to a challenge and observe NGC 1049. I was well aware that with a published magnitude of 13.7 and size of 30" this globular would stress my 8-inch SCT to its limits. Armed with *Uranometria 2000.0* and my binocular viewer, I had no trouble finding the exact location. NGC 1049 showed up quite easily. With direct vision it appeared almost stellar with an estimated magnitude of 13, and averted vision revealed a fairly small diffuse glow. As I could simply not believe how easy this observation went along, I scrolled through my literature to confirm the position of NGC 1049 against the star field.

I found a nice, detailed Schmidt photo in the European Southern Observatory book *Exploring the Southern Sky* (Springer-Verlag, 1987) and was able to confirm my observation. Even better, the photo also showed two more globular clusters in the same area with apparently similar sizes and brightness. Taking the book outside with me a few nights later, I first went to globular #1 (in RA order, NGC 1049 is #2) and could see nothing at first. Only after staring at the field for some 10 minutes could I see a ghostly glow popping in and out of view. Phew...this was a tough one! Estimated at 14th magnitude, #1 is the first anonymous globular cluster I have ever observed, and this with a humble 8-incher! Globular #3 was easily spotted as a very small glow of about 13th magnitude. This one was probably even more apparent than NGC 1049. The enclosed sketches show a low power field (please note that east and west are reversed due to using a diagonal mirror with the SCT) and three more detailed views of the individual globular clusters.

Northern hemisphere observers may need apertures beyond 10 inches to duplicate my observations, as Fornax passes virtually overhead from my observing site, giving me an unfair advantage! You can imagine that I felt very proud having observed such "exotics." Unusual observations such as these give me a big thrill and motivate me to search for even more challenging objects, of which there are still plenty to discover in the southern hemisphere. □

Gerd Bahr-Vollrath is fast gaining a reputation for his spectacular sketches of deep-sky objects.

DEEP SKY STARMART

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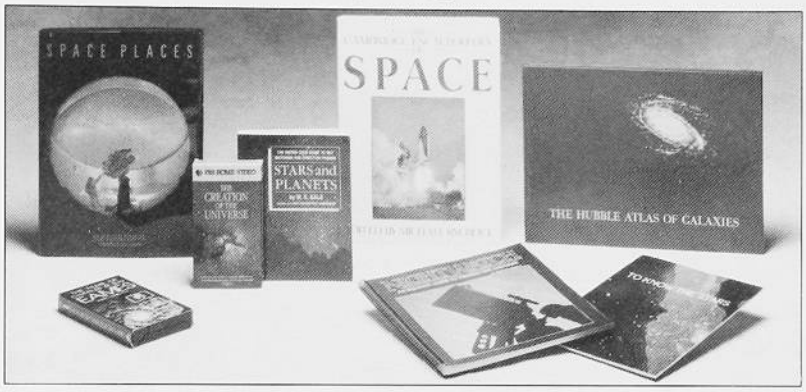

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Deep Sky Reports

Summer's Challenging Deep-Sky Objects

by Phil Harrington

Hard as it is for me to believe that it's summer already (why, it seems like New Year's was just yesterday), there is no denying that warmer weather is here. And while the frigid nights of Winter may cause some amateur observers to think about taking up another hobby, mild Summer nights permit all of us to spend more time at the eyepiece in pursuit of new and challenging sights.

Since I began this column two years ago, I have relegated the summer installment to the search and observation of planetary nebulae. Here, I continue that tradition by offering some formidable planetaries that are sure to test both you and your telescope. Give each a try when the Moon is absent and the sky is clear.

Giant binoculars and 2-inch to 3-inch scopes: NGC 6572

R.A. 18h12.1m, Dec. +06°51′ Constellation: Ophiuchus Magnitude: 9.0p Size: 15"x12"

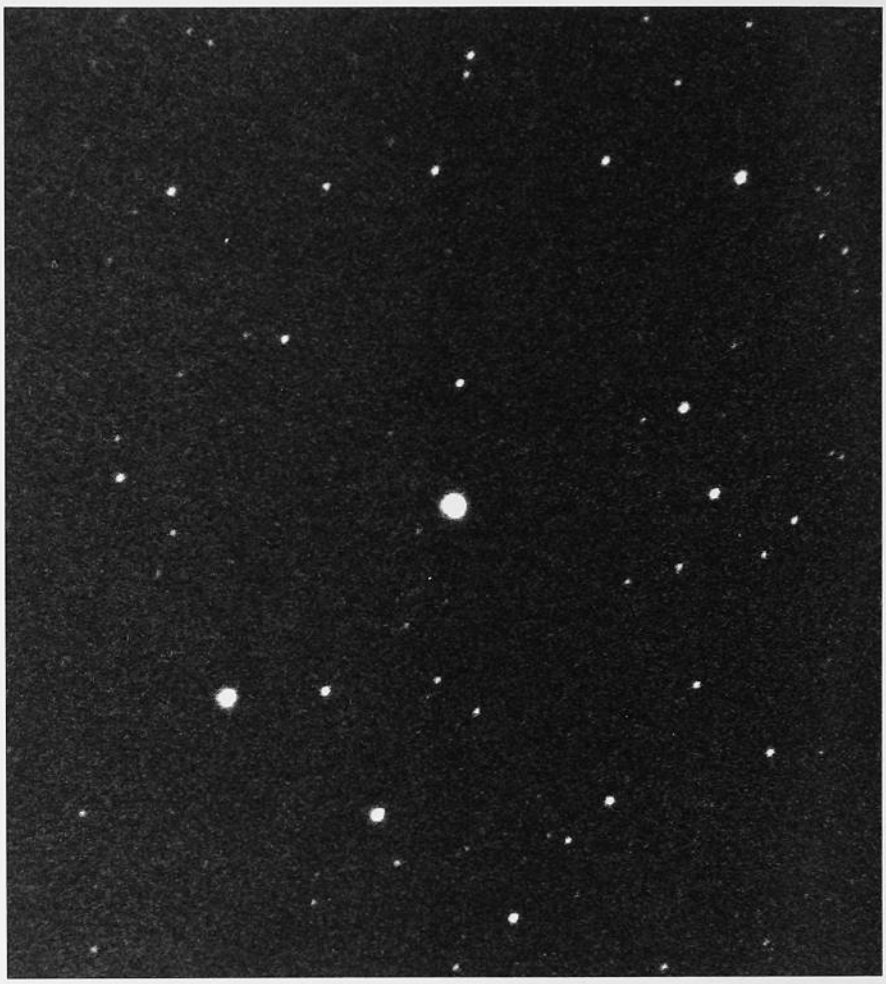
NGC 6572 is the brightest of the nearly fifty planetaries within Ophiuchus, although many amateurs seem to ignore its presence. Perhaps this is due to the lack of bright field stars in its immediate vicinity. Still, the few extra minutes required to search out NGC 6572 will pay off greatly in the end. Even the smallest telescopes display a striking bluish-green oval disk.

As magnification climbs, so will the nebula's size, but don't expect to glimpse its central star easily through smaller telescopes. Though it is rated magnitude 12, I have never spotted it through my 8-inch f/7 Newtonian. As is the case with so many other planetaries, this is probably due to the high surface brightness of the engulfing nebulosity—an interesting twist to the phrase "light pollution." It's not that the star is exceptionally faint, but rather that the contrast between it and the surroundings is so low (the Ring Nebula's central star is probably the best known example of this).

4-inch to 6-inch scopes: NGC 6369

R.A. 17h29.3m, Dec. -23°46′ Con.: Ophiuchus Mag.: 12.9p Size: 30"

Nicknamed the "Little Ghost Nebula," NGC 6369 is readily found only 30′ northwest of 5th-magnitude 51 Ophiuchi. Appearing much like a miniature Ring Nebula, NGC 6369 is an exciting planetary nebula to view at moderately high magnification under clear, dark skies. When the air is especially crisp, the nebula's pale blue hue may be detected through 4- to 6-inch telescopes; otherwise it appears grayish (larger instruments will display the bluish color under less than perfect conditions). Photographs also reveal a faint ghostly halo measuring a full arcminute surrounding the brighter inner ring. While the largest backyard instruments may be used to successfully photograph this latent feature, it is probably too subtle to be seen visually. The nebula's central star is also a tough catch even through the largest amateur instruments, as it glows weakly at 16th magnitude.



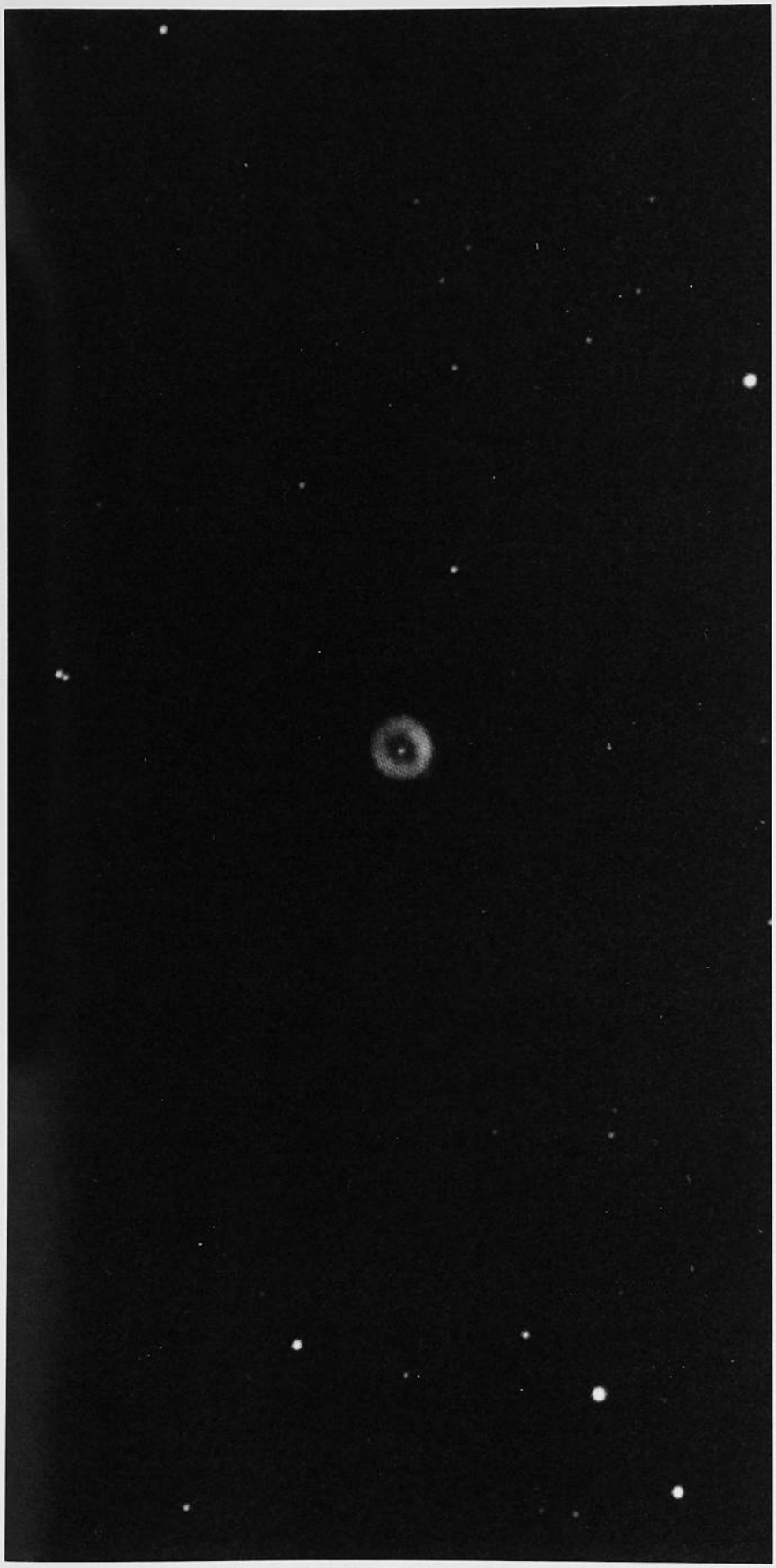
NGC 6572 photographed by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 9-minute exposure).

8-inch to 10-inch scopes: IC 4846

R.A. 19h6.5m, Dec. -09°03′ Con.: Aquila Mag.: 12.7p Size: 2"

Nestled to the southeast of Lambda Aquilae (marking the Eagle's tail feathers) is a small planetary nebula catalogued as IC 4846. Even at magnifications in excess of 200x, telescopes in this size class will reveal little more than a dim stellar object at these coordinates, making the nebula difficult to distinguish from the many stars that surround it. But this should not stop a diehard planetary nebula observer — we just have to be a little more clever.

One way to successfully identify these miniature nebulae is by using a small slitless spectroscope. While starlight passing through the spectroscope will be scattered into a cascade of col-



NGC 6369 photographed by Jack B. Marling (24-inch f/15 Cassegrain, hypersensitized Fujichrome 400 film, 30-minute exposure).

ors, the doubly-ionized oxygen (O III) of the planetary nebula will cause the cloud to remain a point. Of course, not all of us have a slitless spectroscope at our disposal, but a good substitute is a small 30° prism. Hold the apex of the prism toward the eyepiece and look at a narrow angle through the opposite flat. Give it a try and let me know your results.

Larger telescopes reveal IC 4846 as a tiny disk of uniform gray light. Take a careful look toward the middle of the nebula for its central star. Glowing through the surrounding cloud at magnitude 13.7, it should just be visible with large amateur instruments at maximum magnification.

12-inch to 14-inch scopes: IC 4732

R.A. 18h33.9m, Dec. -22°39′ Con.: Sagittarius Mag.: 13.3p Size: 3″

IC 4732 is a faint object located to the northwest of the dazzling globular cluster M22 in Sagittarius. Catalogued at photographic magnitude 13.3, its 3" disk proves very difficult to pick out from the myriad of neighboring field stars. Even from under dark, steady skies, I have never been able to positively identify it through my 8-inch Newtonian equipped with a high-power eyepiece; subsequently, my 13.1-inch f/4.5 reflector at 214x picked it out from the crowd using the "in-and-out" nebula filter method (known to some as the "flicker method"). By alternately removing and inserting a narrow-band nebula filter between the observer's eye and the eyepiece, the planetary will appear to brighten relative to the background stars. (This is only an illusion — the filter actually dims everything but affects the stars more than the nebula.)

Regardless of the instrument and magnification used, IC 4732 will be seen as little more than a stellar point of light. And while few amateurs have spotted IC 4732, even fewer can claim to have glimpsed the central star — it is thought to glow at a dismally faint magnitude 16.6.

Do you have a favorite planetary nebula, or some other object that you would like to challenge other readers to see? If so, drop me a line at the address below and I will try to include it in an upcoming issue. And enjoy the warm nights while you can — winter is just around the corner! □

Phil Harrington has written for this magazine for many years. In 1990 he published his first book, Touring the Universe Through Binoculars *(John Wiley & Sons).*

Touring the Universe through Binoculars; a complete astronomer's guidebook by Philip S. Harrington, (John Wiley & Sons, 1990), ISBN 0-471-51337-7, softcover, 294 pages, $24.95.

As binocular observing becomes established as a primary means to view the sky, more books on the subject have reached print. The most recent to join the ranks — and by far the most complete — is Phil Harrington's *Touring the Universe through Binoculars*. Harrington's aim with this book was to produce the most thorough examination of suitable objects for binoculars. And at that he has succeeded. Listing over 1,100 deep-sky objects, this book greatly overshadows other books on the same subject. Furthermore, this book deals with the most recent development of the binocular design and technology. The book begins with a brief justification for observing with binoculars. After that, the author jumps right into observing, beginning with solar system objects like the Moon, planets, comets, asteroids, and even the Sun.

Before moving into the catalog, Harrington devotes a chapter to the various types of objects in the sky — double and multiple stars, variable stars, clusters, nebulae, and galaxies. He also discusses the various catalogs from which the book has drawn information. The chapter concludes with a few project suggestions for serious amateur astronomers, but not before providing a list of the Messier objects with indication of the skill level required to see each. This is extremely beneficial to the neophyte who is not sure what to expect or if the object is at all.

The heart of the book consists of a massive description of objects. The author presents the constellations alphabetically for easy reference and covers all 88. Each constellation begins with a list of several objects in catalog format.

Included are object designations, types, coordinates in equinox 2000.0, magnitudes, sizes, (separations and periods for double and variable stars), and a brief set of comments. Following the catalog listing of objects is a detailed description of some of the more interesting objects. The descriptions reflect Harrington's extensive experience as an observer.

NGC 6888 (Kim Zussman, modified 11-inch f/10 SCT, hypered Tech Pan film, 120-minute exposure).

Fortunately, the objects listed are not just a rehash of the most popular deep-sky objects found in other books. *Touring the Universe through Binoculars* covers many objects most amateurs would have never thought visible in binoculars. Harrington's mastery of binocular obsering shows in the descriptions as he mixes first hand accounts with personal preferences.

The book is adequately illustrated with black and white photographs, usually with wide angle shots. This is a plus since binoculars generally offer wide fields. So the reader gets a eneral sense of the proper angular size an object might be in field glasses. However, photographs show far more detail than is visible to the eye. As a result, readers may get a false impression of what many of the objects will look like. Simple drawings or sketches would have been helped with this.

One major problem with the book is the noticeable lack of star charts. Many other binocular observing books offer simple constellation charts giving the reader an idea of where each object is in relation to the brighter stars. No charts are found in *Touring the Universe through Binoculars*. Furthermore, no mention is made of star charts, either on how to choose a good one or use one. This problem is exacerbated by the two factors. First, not all the objects listed in the catalog are mentioned in the accompanying text. The reader is on his or her own to find them on a star chart. Second, of those objects described in detail, not all contain star hopping directions.

The book concludes with a few short appendices. Topics include selecting a pair of binoculars, appropriate mounting platforms, care and maintenance, a partial listing of binocular manufacturers, and a short bibliography. A few of the topics, particularly the section on choosing binoculars, would have been better suited as introductory information, especially for novices.

Despite its shortcomings, the book is excellent and a welcome addition to any amateur's library, regardless of whether binoculars are a primary or secondary instrument.

No single astronomy book covers every aspect of the subject — theory and observation — simply because astronomy is too broad and diverse. Amateurs desiring well-rounded knowledge must seek out several books, and hope they can find a good set, all aimed at a comparable audience. Cambridge University Press has alleviated the need to compile a set of books covering every aspect of astronomy. Their new series, dubbed the *Greenwich Guides*, covers just about every topic in astronomy in a

non-technical language, perfect for the newcomer to astronomy.

All the books are lavishly illustrated both with photos and drawings. The photos are high-quality and, refreshingly, many of them are previously unpublished, rather than a reiteration of the same photos printed elsewhere.

The books are well cross-referenced. When a topic is covered better in another book, the authors point out which book to turn to.

If the series has any drawback it is the technical editing. Specifications and facts sometimes vary from book-to-book. For example, the number of Saturnian satellites varies between books: *The Planets* indicates there are 17 while *Astronomy in Action* states there are 21.

One nice feature about any series of books is the reader can purchase only the books of interest. After reading one of the *Greenwich Guides*, however, most readers will opt for the rest of the series. Reviewed separately below, the series includes *The Planets*, *Astronomy in Action*, *Stargazing*, and *Stars, Galaxies and Nebulae*.

The Greenwich Guide to Stargazing by Carole Stott, (Cambridge University Press, 1989), ISBN 0-521-37775-7, paperback, 96 pages, $9.95.

Of all the *Greenwich Guides*, this one is the most suitable for observers. The others deal more with theory and fact, rather than observation.

The book is logically oriented, starting with information about the sky, how to find your way around and some background on early star atlases. With this information understood, the book moves into the specific types of objects to observe; double stars, variable stars, star clusters, nebulae, and galaxies.

Descriptions are concise, and for the most part, accurate. If the book has any faults it is that it is too simplistic, at times oversimplifying things. For instance, the section on variable stars describes a supernova as a star that explodes. This is true of a type II supernova, but not a type I, which is not even mentioned.

Following the object descriptions are sky charts, which take up a good portion of the book. The first set of charts shows large portions of the sky to give the reader an idea of when each constellation is visible and where they are in relation to each other. Following this are more detailed charts of selected constellations. These charts show stars down to about magnitude 5.5 and highlight some of the brighter deep-sky objects.

The thrust of the book is naked eye stargazing. The author does provide some guidance on choosing an instrument once the observer has reached the desired level. Binoculars are given more attention than telescopes.

The Greenwich Guide to Stargazing is an excellent introduction for the entry level stargazer.

The Greenwich Guide to Astronomy in Action by Carole Stott, (Cambridge University Press, 1989), ISBN 0-521-37774-9, paperback, 96 pages, $9.95.

Of the entire series, I like this book the best. This work focuses on how astronomy is performed, both on Earth and in space. It gives the reader an idea of what it's like to be a professional astronomer working in the field.

Astronomy in Action also focuses on what current astronomical research has revealed and what we have learned from it. The information is reasonably up-to-date — considering how quickly our knowledge and understanding of the universe changes.

The book begins with a chapter devoted to the life of an astronomer, giving the reader a good idea of professional astronomy as work.

Next, the book covers instruments used to observe the sky, beginning with optical instruments before moving on to radio telescopes. *Astronomy in Action* discusses observatories of the world and recording techniques used by astronomers. The CCD chip is described and photos are included to illustrate its performance.

Realizing the limits of observing from Earth's surface, the author builds a case for observing in space. Aside from the obvious seeing restraints, the book details the need to see radiation blocked by the atmosphere, specifically X-ray, gamma-ray, and certain wavelengths of infrared.

The work astronomers have done in orbit — Skylab and the various shuttle programs — are given a fair treatment. The final portion of the book deals with planetary probes. This section does overlap slightly with the book specifically devoted to the planets, though not much.

The book concludes with a brief discussion on how to get involved in astronomy, listing addresses of organizations to join and professional observatories to visit.

The Greenwich Guide to Stars, Galaxies and Nebulae by Stuart Malin, (Cambridge University Press, 1989), ISBN 0-521-37777-3, paperback, 96 pages, $9.95.

Although the title might suggest it is observational in nature, this is actually a theoretical book. It covers the mechanics behind the objects in the sky (i.e., those listed in the title).

The first chapter is somewhat mind-boggling for an introduction. It covers the size of the universe and the nature of time. When presenting an overview of the universe, I think it is best to start off close to home with familiar surroundings and work out from there. Such ethereal topics like the nature of time should be reserved for the latter chapters.

The second chapter deals specifically with the sun. The author introduces the principles of thermonuclear reactions which power the sun. In addition, solar features — sunspots, prominences, and atmosphere — are discussed. The author uses this discussion to step on to the next chapter which deals with stars in general. Topics on distance, brightness, and the overall life cycle are covered.

Next, the author turns to nonstellar objects — star clusters and galactic nebulae. The author discusses what each object is and how it fits into the grand scheme of the universe. The book gives a brief description of each category's appearance, both visually and photographically. The work is true to its focus concentrating on the nature of the object, not the observation.

Chapter five deals with the various types of galaxies, or "extra galactic nebulae" as the author calls them (in rather painfully outdated style). The various types of galaxies — spiral, elliptical, irregulars, etc — are covered with good photos to illustrate the visage of each.

The sixth chapter covers exotic objects of the night sky — pulsars, quasars and black holes. The author clearly states what we know as fact and what we deduce from theory.

The seventh and final chapter is a short rationale for studying astronomy. Such topics are well worth exploring because astronomy is basically a curiosity science that does not benefit mankind directly as biology or medicine. This is very informative for anyone who ever doubted the need to fund astronomical research.

The Greenwich Guide to the Planets by Stuart Malin, (Cambridge University Press, 1989), ISBN 0-521-37776-5, paperback, 96 pages, $9.95.

Like *Stars, Galaxies and Nebulae*, *The Planets* is all theory. No mention of observing techniques is discussed anywhere in the book.

The book begins with an overview of the solar system which includes some historical information as to how our

current view evolved. After that, a separate chapter is devoted to each of the major planets including Earth.

The Sun and Moon are combined into a single chapter as are the lesser solar system bodies like comets, meteors, and asteroids.

Each chapter dealing with the planets begins with a short summary describing size, distance from the Sun, mass, density, orbital and rotational period, and number of satellites. For the Jovian planets, a table summarizes satellite information, like name, size, mass, orbital period, and orbit size. The text goes on to describe how the planets looks from earth and spacecraft and information on composition. This reminded me of an encyclopedia with more pictures and more accurate information.

The last chapter explores the possibility of life elsewhere in the universe. The author does not draw any definitive answers, but works with probability based on the predicted number of stars in the universe. The ultimate conclusion is left to the reader.

The Trained Eye; an introduction to astronomical observing by Leon Palmer, (Holt Dryden Saunders, 1990), ISBN 0-03-047363-2, paperback, 200 pages, $9.50.

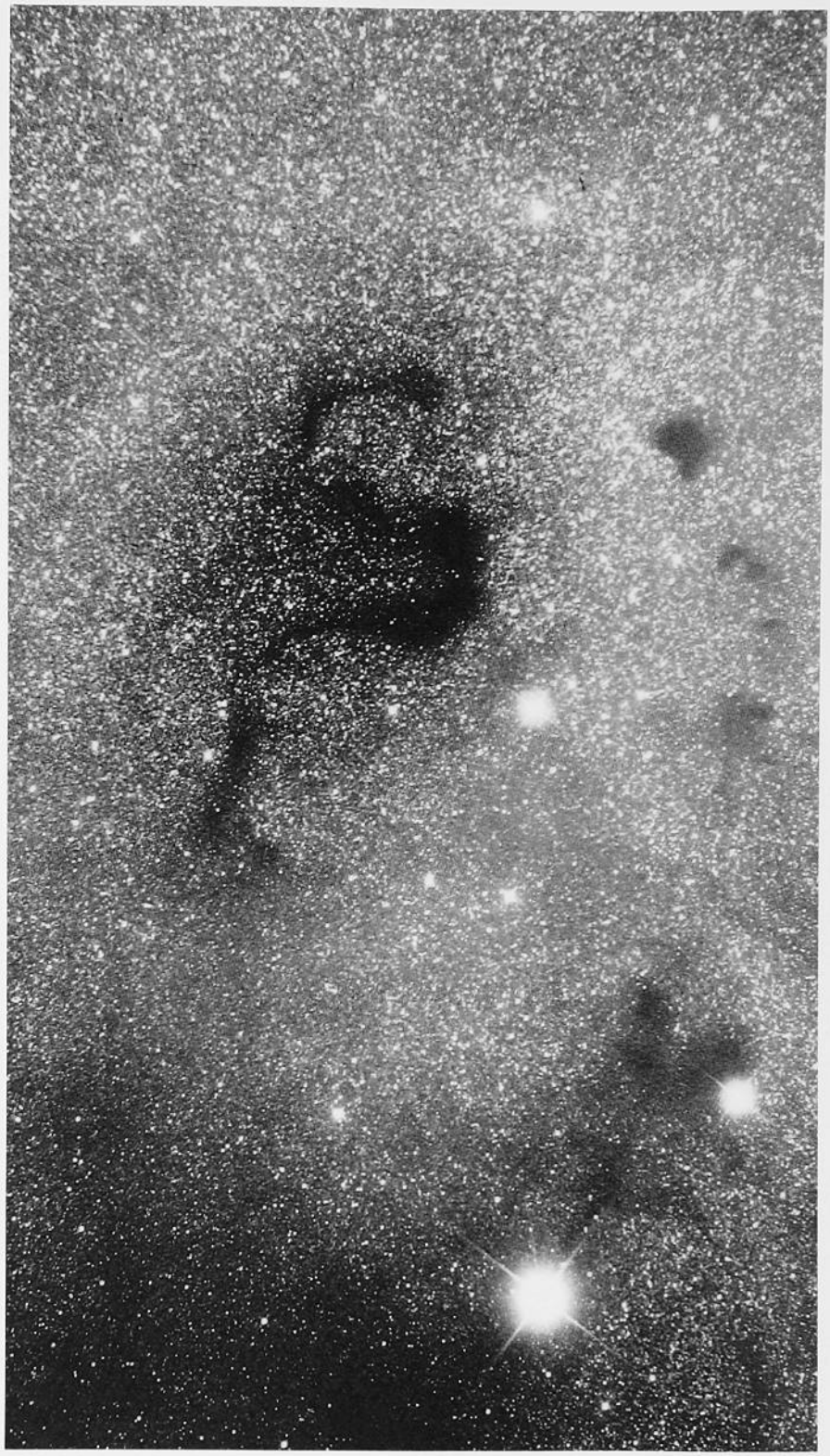
When I was in college, astronomy lab manuals were usually written by the professor teaching the class and published by the campus reproduction center. This meant the content was tailor-made to the course, but the look was somewhat mundane and rough.

But times have changed. Several major publishing houses have ventured into lab manuals, several of which are quite good. One in particular is *The Trained Eye* by Leon Palmer, an astronomy professor at El Camino College.

Like any astronomy lab manual, the primary thrust of this book gives students a hands-on introduction to observational astronomy. Projects cover how to use a star chart, measuring a telescope's field of view, estimating stellar magnitudes, and more. The topics are laid out logically so that information learned in earlier exercises applies to later exercises.

Accompanying the text are blank tables to be filled in by the student during the observing or class session. Likewise, small circles representing the telescope's field are included so drawings can be made of objects observed. I found that the drawings clearly illustrate the points made in the text.

But *The Trained Eye* is not all field work. As anyone who has ever taken an astronomy lab will tell you, not all class nights are clear. On those occasions, something must be done. In light of this, Palmer has included several exercises for those cloudy nights. They include classifying stars, mapping the heavens, and plotting stars on the HR diagram.



B72 (Michael Stecker, 8-inch f/4 Takahashi, hypered Tech Pan film, 30-minute exposure).

A short description of each project at the beginning of the book informs the reader which are done inside and which are done outside. This book was designed to be used in the field. Special projects which call for sketching can be done right in the book. The pages are perforated so assignments can be removed and turned in for grading.

At the end of the book we see eight

charts in equinox 2000.0 coordinates that show stars fainter than fifth magnitude. The book's major fault is that it is plagued with typos. It seemed as though ever time I opened to a new page I found at least one, sometimes more.

For a college lab book, *The Trained Eye* is very good. But someone interested in learning about the sky and astronomy on his or her own using a systematic approach will also find this book worthwhile.

Exercises in Practical Astronomy using Photographs; with solutions by The M. T. Brück, (Adam Hilger, 1990), ISBN 0-7503-0061-2, hardcover, 128 pages, $40.

At the other end of the lab manual spectrum is *Exercises in Practical Astronomy using Photographs*. This book is intended for students pursuing degrees in astronomy. The concept allows students to interpret observations (the photographs) without doing the observations themselves.

Most of the exercises are old in that we already know the answers, but the idea of this book allows students to work out the answers based on observations (the photographs) that others have made. Needless to say, this saves a tremendous amount of time since the reader is responsible for interpreting the data, not collecting it.

The exercises range from determining the Sun's rotation to calculating the orbital periods for minor planets. Some of the exercises are fun, and challenging enough for even the most ardent amateur astronomer. One of my favorites was on galaxy classification. Listed are several galaxy photos which the reader must classify by type. Simple line drawings are included which identify the various types and aid in classifying those shown in the photos. This exercise shows that it's not always easy to place objects in categories.

Each chapter has suggestions for completing the exercise and the solutions are listed at the back of the book so the reader can check the results.

The major drawback of this book is its price. At $40, it looks as though Adam Hilgar is trying to give Springer-Verlag some competition to see who can charge the most for a book.

The book succeeded as a manual for students majoring in astronomy, but advanced amateurs will also find the book interesting. It will certainly test your skill at interpreting data and understanding how professional astronomers work.

The Night Sky by Dennis Mammana, (Running Press, 1989), ISBN 0-89471-764-2, paper, 94 pages, $9.95.

Getting the younger generation interested in astronomy is of concern to popularizers of astronomy. Video games, television and a host of other distractions have diverted the attention of the next generation from one of nature's greatest wonders — the night sky. While there are several good astronomy books for kids, most fail for two reasons. First, they are mostly descriptive in nature talking about how things look in the night sky and what they are made of. While this is not bad in and of itself, these books fall short by not encouraging the reader to go out and look at the sky. Second, books miss a very important age group. Many of the children's astronomy books I have seen are geared toward younger kids, under 8. The formidable years — 10 through the early teens — are ignored. *The Night Sky* by Dennis Mammana is one of the first to target at least part of this group. Probably best for the 8 to 12 year old range, this book is uniquely balanced between observation and experimentation.

For the most part, the book is well organized, following a logical flow. I was taken back at first since it begins with a chapter on observing artificial satellites. Though this section is only a few pages, it probably belongs further back in the book.

But after this, everything flows well, beginning with objects that are bright enough to be seen from the light polluted skies of large cities. The author discusses everything from how to tell the difference between a star and a planet and how to use a star map. The author even includes a chapter on how to become an astronomer.

As I mentioned earlier, *The Night Sky* is remarkably balanced between observation and experimentation. For example, in the chapter on the Moon, Mammana gives the readers a simple experiment to illustrate why the moon goes through phases. He also encourages readers to go out and observe the lunar phases and various lunar features. But he doesn't stop there. Mammana also gives simple experiments to illustrate how some lunar features, particularly lunar craters, were formed. All the materials needed for these simple experiments are easily found household items. The illustrations are fantastic. Even without performing the experiments listed, the reader can easily deduce conclusions based on the drawings.

If you have a child or know of one who is interested in astronomy, *The Night Sky* is the perfect book to foster that interest and turn it into a hobby that will last a lifetime.

The Observer's Sky Atlas by Erich Karkoschka, (Springer-Verlag, 1990), ISBN 0-387-51588-7, paperback, 130 pages, $14.95.

When it comes to pocket sky atlases, *The Observer's Sky Atlas* from Springer-Verlag is hard to beat. Intended for neophyte observers, this book is packed with information on hundreds of deep-sky objects. Even more experienced observers will find this book a welcome addition to regular observing equipment.

The heart of the book is the star charts — 50 in all — covering the entire sky. The charts are arranged first by season, then by hemisphere, starting with the north and working south. Technically, the charts can be broken down into two categories; wide field and narrow field. The wide field charts shows large swaths of sky, lists stars to sixth magnitude and highlights a single constellation or small pieces of several constellations. On the same page, inset off to the side of the main chart, are close-ups of selected areas. Both charts list key objects, with the narrow field charts giving more detail and showing stars to ninth magnitude.

A list of objects found on each chart is directly opposite the chart. Objects are listed in one of four categories: nebulae, stars, binary stars, or variable stars. The table also lists key data for each objects, such as magnitude, size, type of nebulae, distance, constellation, and coordinates (in epoch 2000.0).

Below the table, objects of interest are described in more detail. The brevity of the object descriptions is one factor that shows the books intended audience. Although the comments are direct and easy to understand, the lack of punctuation makes the descriptions run together and, as a result, difficult to read.

Preceding the charts is a discussion of the night sky. This includes information on scale, direction, and magnitudes. The author also describes each object by type; galaxies, nebulae, star clusters, variable stars, double stars, etc. This gives the reader the basics needed to use the charts to their fullest. One pleasant surprise is the book's low price. As an academic press, Springer-Verlag usually charges exorbitant prices for even their small books. But the content and price make *The Observer's Sky Atlas* appealing to observers of any level. □

Mark J. Coco is a staff member at Celestron International.

Small Scope Showcase

The Big Picture

by Alister Ling

Binoculars can be too much — magnification, that is. The wonderful views at 7 or 10 power are a delight to behold, but sometimes it's fun to push oneself to the lower limit. We can observe many interesting objects at a magnification of only 2 diameters!

What's the minimum aperture required for the Helix? Is it possible to see those large and tempting nebulosities, so prominently displayed on 50mm piggyback photos? What treasures await the observer? Read on! I'll answer these questions and more.

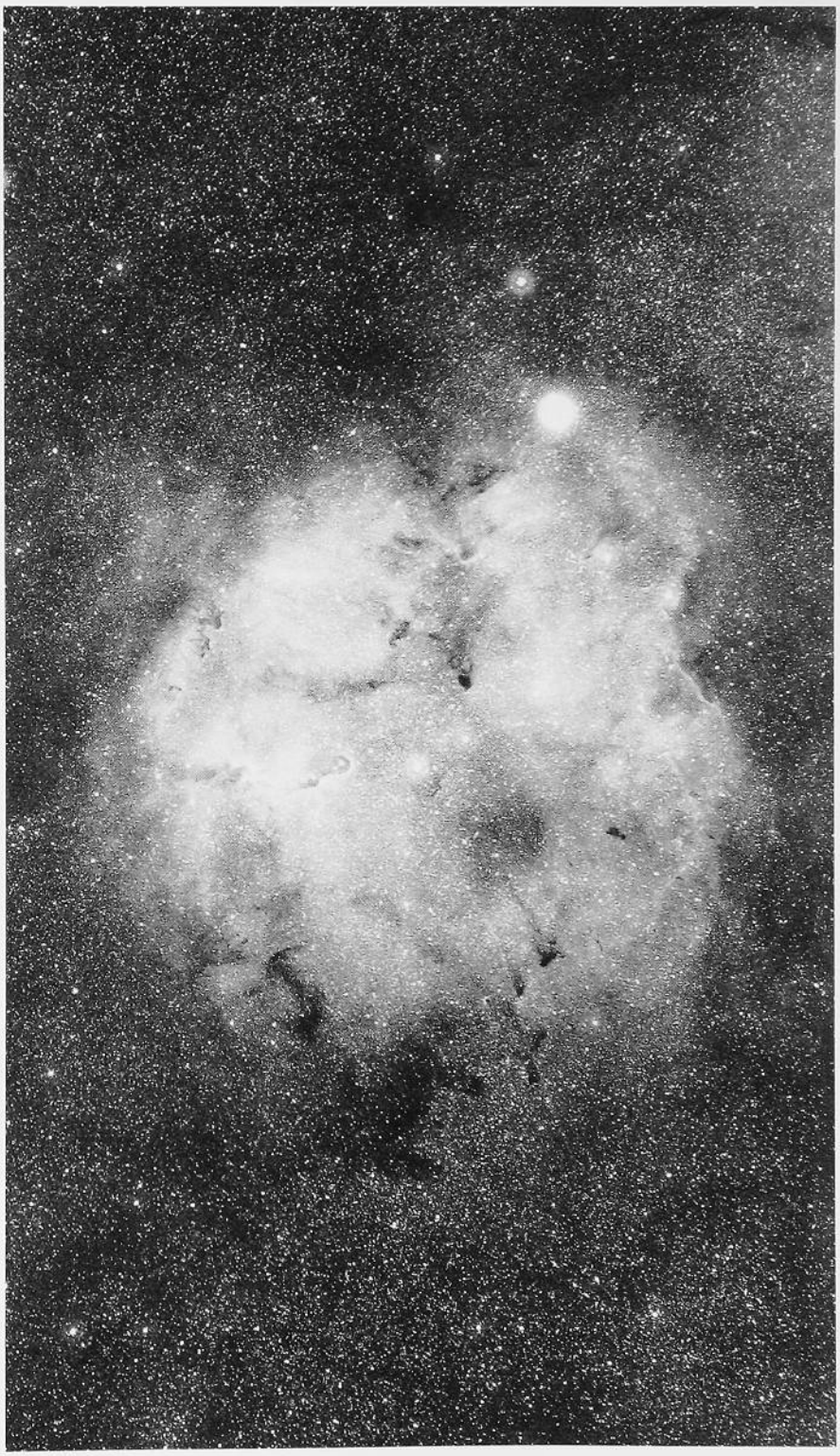
A few years ago I stumbled into the realm of exotically low power observing. My modest start was achieved by connecting a low power eyepiece to my 400mm telephoto lens. It was nothing more than a cheap copy of a spotting scope, ideal to carry around when I was not the only observer in someone else's packed car. The 14-power scope was a treat to use. Soon enough it dawned on me to attach the eyepiece to my 135mm telephoto for a 5-power mini-scope, then finally to a 50mm camera lens to provide just under 2x!

The key to connecting the camera lenses to the eyepieces was a machined adapter with threads on one side for the camera lens and an eyepiece holder on the other, much like the "visual back" of SCTs. A Daystar 300 nebula filter placed in front of the eyepiece completed the unit.

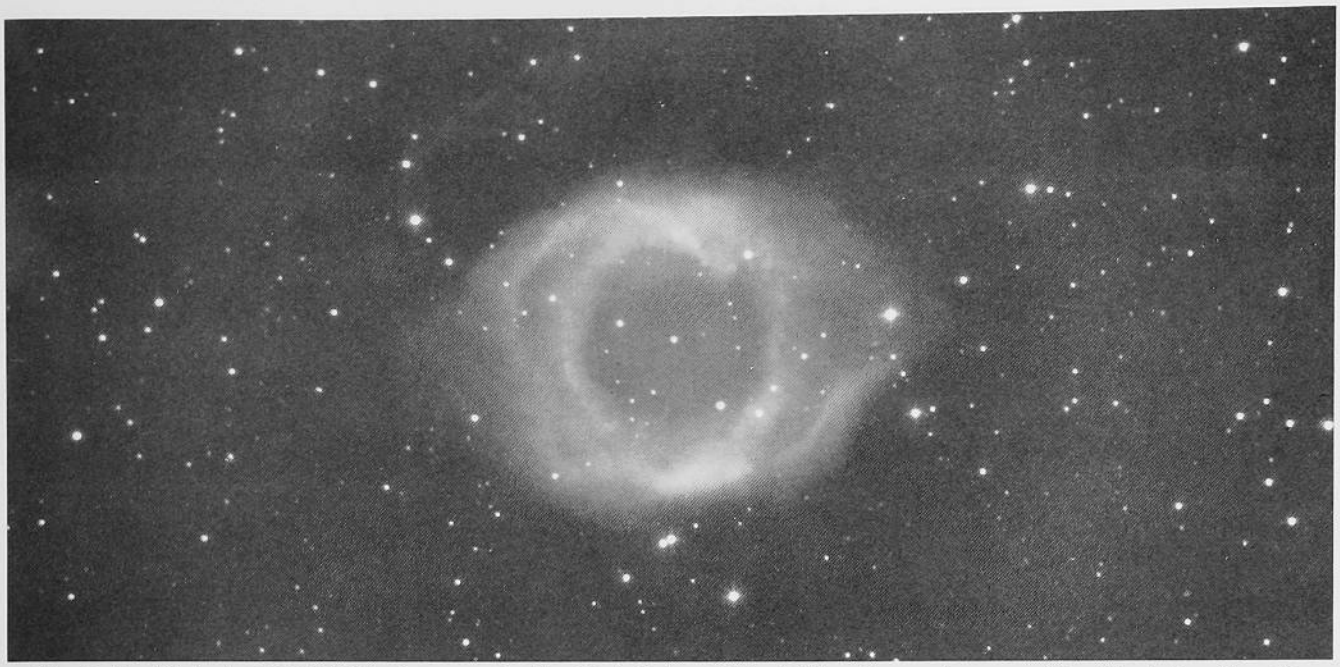
The narrowband design of the nebula filter allowed objects like the Helix — NGC 7293 — to jump right out of the background sky. At 19x it is obviously non-stellar. Due to the lack of bright stars in the vicinity of the Helix, this large planetary still stood out sharply at 5x. My lower limit for detecting the Helix seemed to be about 1.5x, achieved by a 2-inch 32mm eyepiece behind the 50mm lens.

Some of you may have realized that the exit pupil for such a mini-scope is around 20mm. Since the eye's maximum opening is around 7mm, there is a lot of wasted aperture in this system, but we're not worried. In essence, the unit works at an effective aperture of 11mm! (7mm x power.)

The Lagoon, the Swan, and the Eagle nebulae stand out in stark contrast against the sky. Although they are visible in normal finder scopes as grey patches, the filtered view at 1.5x gives



IC 1396 photographed by Chuck Vaughn (350mm f/2.8 lens, hypersensitized Tech Pan film, 60-minute exposure).



The Helical Nebula (NGC 7293) photographed by Chris Schur (14-inch f/5 reflector, hypersensitized Tech Pan film, 45-minute exposure).

them a bright "white" look. I have trouble finding words to describe the emotional impact of the remarkable changes in appearance. One feature common to all of these objects is how huge they become. The unfiltered view through a telescope only reveals the brighter central mass, with hints of fainter nebulosity around. The wide field and high contrast of the mini-scope dramatically reveal the tenuous outer glow seen on photographs.

Swinging higher along the Milky Way leads us to the fertile ground of Cygnus. In itself, the unfiltered view at 1.5x readily contains the whole of the Northern Cross. The main problem of navigating with the mini-scope is that the field orientation is upside down. At Stellafane, lying down on the brick wall up by the clubhouse, I solved this problem by pointing my feet point north and my head south. The slight magnification allows one to inspect the Great Rift and other dark nebulosities with ease. With the whole constellation in sight, one can't get lost, which occurs on occasion with binoculars at 7 power.

A narrow band filter placed in the light path highlights the North America and Pelican nebulosities. Unfortunately, the arcs of the Veil nebula are too thin to show up at very low power, so it will take some experimenting to find the point where they can be detected. Other inviting but difficult nebulosities to observe are those near Gamma Cygni, the central star in the Cross. Gamma scatters a lot of light, which makes these emission objects a challenge in any scope.

The greatest drawback of the mini-scope is the lack of binocular vision; however, there are a number of advantages. As a strongly astigmatic eyeglass wearer, I have trouble using binoculars. I can't see all view because the eye relief is not long enough. The eyeguards also smudge my lenses. This is a pity, since binoculars in a dark sky give unparalleled views. The mini-scope can also have different magnifications, as noted above. Some of the smaller constellations like Cassiopeia and Lyra, and asterisms like the Teapot, are a delight at 3x.

By far, filters are the most powerful tool available to the deep-sky enthusiast. Wouldn't it be great to have filter wheels on binoculars? A tad expensive, though. A broadband filter would darken the skies just right for those hazy summer nights. The narrowband and line filters are most suited for emission nebulae. I am planning to survey the large Milky Way nebulosities with both O III and H-Beta filters. I hope to find some objects which are significantly better through one filter than another. For some time we have known that the California Nebula is clearly more visible in an H-Beta filter than with an O III. Plenty of big objects await the observer in Monoceros, Cassiopeia, and Cepheus.

Cepheus is home to the large emission nebulosity IC 1396. With a great amount of patience I found it to be a difficult object at 14x with the 400mm telephoto spotting scope, even with the Daystar filter. At 1.5x, however, it stands out as a large glowing patch embedded in the Milky Way.

The California Nebula has been mentioned numerous times by Walter Scott Houston in his column in Sky & Telescope. It is easily visible with an H-Beta filter together with the naked eye. Because line filters like the H-Beta reflect a lot of light from their multicoated surfaces, one needs to place the filter at the end of a small tube to prevent ghost reflections from interfering with the image. What other subtle naked-eye wonders are waiting to be discovered?

I would like to hear from readers on how they succeed with low power filter-aided observing. There are a lot of "ground-breaking" experiences to be made. If only I had several lifetimes to live — but the observable universe is just too big and detailed to be absorbed by one observer with several interests.

In closing, I would like to mention that there are other perspectives to be gained with "opera glass" observing. One can imagine and experience what it would might be like to have owl eyes. At 1.5x, with 11mm eyes, the Beehive Cluster (M44) resolves into stars from its smoky cloud. Vague patches in the Milky Way become incredibly more tantalizing with just a bit more optical power. Try to contemplate how mankind's concept of the universe might have changed if we had started out with bigger eyes and slightly more magnification. □

Alister Ling has many years of experience observing with telescopes both small and large.

Double Stars

Sweeping the Galactic Plane in Cygnus

by Brian A. Skiff

"I had at one time projected a survey of the wonders of this region with a sweeping power; but want of leisure, an unsuitable mounting, and the astonishing profusion of magnificence combined to render a task hopeless for me which, I trust, may be carried through by some future observer."

So wrote T. E. Espin in 1917 in the sixth and final edition of *Celestial Objects for Common Telescopes*, first published by Espin's mentor, T. W. Webb, sixty years earlier. This comment was tacked onto the end of the section describing Cygnus, as though it were a lament that late in life (Espin was nearly sixty) he had not been able to absorb quite everything the sky could offer despite a vigorous career of semi-professional visual observing.

Cygnus provides the richest star fields in the sky for English observers like Espin, rising to the zenith during the most pleasant months of the year. Thus it was natural to think about scanning systematically through the Milky Way here looking for "fine fields" omitted from ordinary deep-sky catalogues. In fact, Espin did a fair job of this himself, noting over 100 such fields in the *Celestial Objects* book, many of them in Cygnus.

Espin was an active double star observer at the turn of the century, and I think he'd approve of checking out doubles while seeking "fine fields." One approach to completing a sweep of the Milky Way is to lamp the telescope in declination and let the sky drift through the eyepiece at low-to-moderate power. As an example of what can be done, let's try to find all the doubles in the +35° zone on *Uranometria* chart 119, which covers the west-central region of Cygnus. I chose this strip of sky because it includes the open cluster NGC 6871, which Espin considered to be the center of the starriest regions in the constellation, and for the more prosaic reason that it passes through the zenith from Flagstaff (selfish of me). The galactic plane also passes diagonally through the chart.

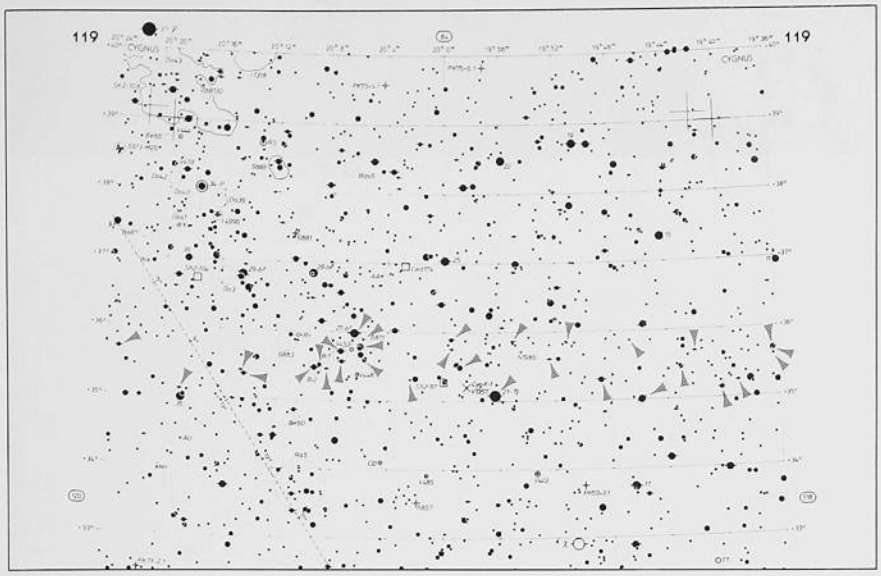
The table lists all the pairs in the 1984 edition of the *Washington Visual Double Star Catalogue* (*WDS*) that are plotted on *Uranometria*. The arrows on the chart itself mark the doubles. Most — but not quite all — are marked as doubles on the atlas with the usual Saturn-like double whiskers. Because of crowding, labels are omitted, but it should be straightforward to identify the stars from the coordinates listed in the table.

ADS/other	RA (2000)	Dec	Mags.	Sep.	pa.	Date	Notes
12667	19 36.2	+35 39	9.3 9.4	0.9	51	1980	
Sei 647	36.3	40	8.1 11.6	28.1	178	1894	
h 1421	36.3	36	10.2 10.6	15.0	230	1925	
12746	38.9	15	8.8 9.2	0.4	223	1979	
12776	40.2	09	8.1 11.1	11.0	287	1933	
12804	42.0	41	9.3 10.5	0.3	164	1979	
12830	43.0	26	9.4 12.4	3:	60:	1910	
12900	45.9	00	6.1 8.6	38.6	26	1958	
12921	46.7	52	8.7 15.2	1.8	191	1922	
12972	48.7	19	6.9 7.9	0.6	164	1985	(1)
13029	51.2	52	9.6 13.6	6.6	240	1926	
13060	52.4	37	9.2 14.7	1.6	66	1922	
13121	55.1	52	9.5 10.5	1.6	261	1978	
13149	56.4	05	4.0 12.0	7.4	208	1958	(2)
13204	59.1	33	8.4 8.9	4.2	297	1966	
13218	59.4	55	8.5 11.2	7.6	329	1933	
13219	59.5	48	10.2 12.2	1.4	162	1947	(3)
13292	20 02.3	19	9.3 11.0	17.6	100	1926	(4)
13361	05.6	36	7.8 8.8	69.5	324	1925	(5)
Sei 849	05.7	54	9.1 12.1	24.1	276	1896	
13374	05.9	47	6.8 12.0	6.6	61	1965	(6)
13376	06.0	46	8.2 12.0	8.6	126	1926	(7)
27 Cygni	06.3	58	5.5 13.7	23.2	64	1924	(8)
13402	07.2	34	9.2 11.4	27.6	117	1895	(9)
13405	07.3	43	7.2 9.7	1.0	84	1981	(10)
13423	08.3	27	9.5 10.7	5.9	129	1935	
Sei 917	08.9	31	8.2 11.4	27.8	338	1896	
13429	09.3	29	7.6 8.6	5.7	302	1969	(11)
13562	14.2	22	7.7 10.5	12.6	257	1933	(12)
13569	14.4	24	8.4 12.4	40.6	130	1926	
13681	18.8	06	8.7 11.1	4.3	240	1981	(13)
13790	23.2	41	8.3 10.9	9.0	203	1933	

Notes
1 - nearly one complete orbit since discovery by Otto Struve.
2 - eta Cygni
3 - U2000 location a little off.
4 - six components within 25" in WDS.
5 - components plotted separately on U2000.
6 - brightest star in NGC 6871; eight components listed in WDS. primary = V1676 Cygni.
7 - in NGC 6871; four components listed in WDS.
8 - primary is a small-amplitude variable, and has proper motion of 0".5/year to the SSW.
9 - in Biurakan 1. primary = Couteau 2125, an extremely close double less than 0".1 apart in 1989.
10 - in Biurakan 1.
11 - in Biurakan 2.
12 - WDS measures suggest substantial motion: could be much wider separation at present.
13 - primary is very close, equal pair 0".2 apart.

From mid-northern latitudes, the region is accessible from the pre-dawn hours in April until November right after dark. Being a fairly unbiased sample, the listed pairs range from impossibly close to uninterestingly wide. A majority, however, can be picked up in a sharp telescope in the 6- to 10-inch range, although high powers will be necessary for some — you won't be able to just sit and watch the sky pass through a wide-field eyepiece. The western end of the strip is kinda out in the middle of nowhere in a little-viewed piece of western Cygnus away from popular deep-sky objects. But it should be easy to star-hop to the first field from either 8 Cygni (V=4.7) near the Lyra-Cygnus border on *Uranometria* chart 118; or from 17 Cygni (V=5.0), which is an easier-to-find star southwest of Eta Cygni near the middle of the long stem of the Northern Cross. Eta Cygni itself is a stopping point in the scan.

The very first pair is one of the more visually interesting objects in the list. **ADS 12667** is a close, nearly equal pair that is marginal for a 6-inch scope because of its faintness; in an 8-incher it should be merely "difficult," and 10-inchers should have no trouble. This pair is one of a triangle of stars; the other two stars are also pairs, but of the wide-and-boring variety. **Scheiner 647** was first catalogued on plates taken for the Carte du Ciel, and being nearly half an arcminute wide, hasn't been looked at since! The other pair was first noted



Uranometria 2000.0 *used by special permission of Willmann-Bell, Inc. Copyright 1987 Willmann-Bell, Inc.*

by John Herschel, and the most recent measure was over fifty years ago.

Folks who think they have a sharp 16-inch telescope might try for **ADS 12746**, a faint sub-half-arcsecond pair. Although this will require 400x to 500x for resolution, at least the stars are similar in brightness. Seeing, rather than telescope optics, may limit you; be sure to wait until the pair is overhead before trying this one. In the same low-power field south and east, **ADS 12776** should be fairly interesting at around 50x in small telescopes.

The closest pair in the strip is **ADS 12804**, most recently measured at 0.3" in 1979. This is the diffraction limit for a 16-inch, but because of its faintness, larger aperture (and perfect seeing!) may be required to resolve the stars. Because of the magnitude difference, it should be easy to estimate the position angle at the eyepiece (in equatorially mounted telescopes) to confirm your sighting. **ADS 12830** has a large magnitude difference, but the pair has not been observed since Jonckheere reported the estimates given in the table in 1910.

Exactly on the +35° line is the bright, unequal pair **ADS 12900**, which should be easy to see in a 20x finderscope. Almost due north, **ADS 12921** will be almost impossible for backyard instruments with its 15th-magnitude secondary. The last measure in 1922 was with the 40-inch Yerkes refractor! **ADS 12972**, on the other hand, should be resolved in a 10-inch, and visible but overlapped in an 8-inch.

The next three pairs, (**ADS 13029**, **ADS 13060**, and **ADS 13121**), all have faint companions, and the challenge is to determine the smallest aperture in which they're visible. I suspect the first can be picked up in a 10-inch, the second will elude all but the very largest and sharpest telescopes, and the third can be picked up in a 6- or 8-inch at 300x or so.

Eta Cygni (ADS 13149) is easily the brightest double in the list, but alas it not terribly interesting, having a faint companion 7" away that is probably unrelated to the primary. The *WDS* lists several other much more distant field stars as well. **ADS 13204**, to the northeast, is a fine pair for moderate apertures at low power. On a 6-inch, 50x will show the two sitting close to each other in a rich field. Perhaps by this time you've noticed that the Milky Way background is significantly richer than at the start of the strip.

Two pairs plotted on *Uranometria* lie not far northeast in a field crowded with stars glowing at magnitude 9 and fainter. In fact, there is some confusion about the identity of the next star, **ADS 13219**. There are several magnitude 10 stars here, most of them pairs, but none quite matches the faint double plotted on *Uranometria*. After checking it against the Becvar *Atlas Borealis* (which shows more stars here than *Uranometria*) and the *POSS*, I have tentatively concluded that the position is in error on the chart, probably because the BD catalogue (source of the star positions in *Uranometria*) is a little off. **ADS 13219** is by far the brightest of four or five pairs listed within a few arcminutes in the *WDS*, and should be identifiable at high power in a 10- to 12-inch aperture. Just to the north, **ADS 12218** is relatively easy.

Crossing the 20h mark, we come to a multiple star, one I'll have on my observing list this summer. **ADS 13292** was first noted by Espin himself in 1905. The B companion listed here is itself a 5" pair, and three more stars lie closer to the primary than B. Be sure to use high power on this one.

At last we reach the peak in star density — "glorious sweeping along 35°30' culminating about 27 [Cygni]..." Espin wrote, noting the open cluster NGC 6871 to the south, which he called a trapezium. The five pairs listed in the table are just the beginning. As noted, multiple components are detailed in the *WDS* (also in *Sky Catalogue 2000.0* for the brighter ones), mostly giving the locations of other cluster stars fairly far away from the primaries. The two brightest stars in the cluster, **ADS 13374** and **ADS 13376**, are the most striking. These give the cluster a remarkable appearance, and remind me of objects in the far-southern Milky Way consisting of a tight knot dominated by one or a few brighter ones, a type of cluster rare in the north. For a taste of Carina, look at NGC 6871.

The sparse (hardly noticeable!) clusters Biurakan 1 and Biurakan 2 both sport two pairs. **ADS 13405**, what might be called the "central star" of Biurakan 1, is an interesting one for high powers in moderate apertures. **ADS 13429** in Biurakan 2 is a nice pair for 50x in small telescopes.

Then suddenly the stars go away. We've reached the galactic plane, but the rich background is gone! Wha' happened? Take your eyes from the eyepiece and look at the sky for the Big Picture. Your telescope is pointed along the edge of the Great Rift, the broad dark lane running up from Aquila and Serpens to the south. The bright Cygnus star cloud lies to the west of the Rift, and we've just scanned a stretch of it. Interestingly, the number of bright stars (say brighter than magnitude 8) stays about the same, but the Milky Way ground of stars magnitudes 10 to 4 is practically gone, except for a few holes in the absorption by dust clouds. Paradoxically, this implies that the band of light we see in this region is composed of stars fainter than about magnitude 9, much fainter than the naked-eye limit!

Likewise for the crowd of doubles, leaving only a few objects straggling to the edge of the map. Of these four, only ADS 13681 and ADS 13790 hold any real interest, and these only at fairly low power. □

Brian Skiff is an astronomer at Lowell Observatory, coauthor of the book Observing Handbook and Catalogue of Deep-Sky Objects *(Cambridge, 1990), and senior contributing editor of this magazine.*

Variable Stars

Keeping Informed

by Paul L. Sventek and Tom Arnold

Variable star observing is a very dynamic sport. Each clear night we observe, the first observing targets we go after are the cataclysmic and irregular variables. There are several different types of variables that belong to these classes, and each has its own particular allure. We'd be willing to bet that if a cataclysmic variable that flared to 1st magnitude every month or two were placed right in the middle of the Big Dipper's bowl or just off an arm of the Southern Cross, observing these types of stars would be much more popular than it now is.

Think of the ancient folklore that would abound behind such an object! We already know the folklore around stars such as Mira (Omicron Ceti, known as "The Wonderful") or Algol (Beta Persei, "The Demon Star"), but what kind of stories would come to us from the ancient Egyptians and Greeks or the American Indians about such a 1st-magnitude intruder in the night sky? Many cataclysmic variables, when faint, are beyond the reach of most amateur instruments. However, when these stars flare, they come into easy view of most any amateur instrument. And as an additional incentive to keep watch on these stars, many professional astronomers want and need to know of the activities of these objects.

If you are as interested as I am in observing and keeping track of the unpredictable activities of cataclysmic or irregular variable stars, you'll need to locate sources of news or observation requests regarding these objects. Most active observers depend upon the American Association of Variable Star Observers (AAVSO) as the primary source of this kind of information, and what we'd like to do here is describe what the AAVSO and other sources provide in the way of variable star news, information, and observation requests.

The primary means to alert observers of special variable star activity or observation requests is through the *AAVSO Alert Notice*. Usually the *Notice* is a single page plus an AAVSO chart or two covering the special star activity or request. Newly discovered novae and cataclysmic or other unusual variables are typically featured. With these charts, observers can go out and participate in gathering data on stars often at the forefront of astronomical research. Now how biased would we sound if we said there aren't many other aspects of astronomy (or any other science for that matter!) where an amateur can participate in such timely research — and from your backyard!

AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

AAVSO CIRCULAR

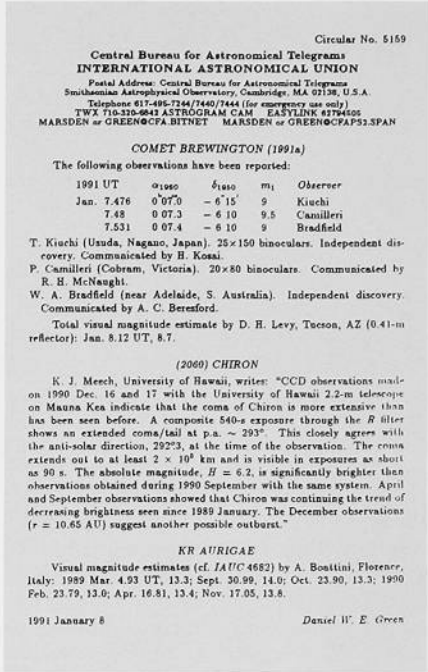
EDITOR JOHN E. BORTLE

No. 242 1990 December

The Following Data Covers Observations for Nov. 1990
Received by Dec. 10, 1990. (Nov. 0.0 = JD 2,448,196)
Final Data Available from AAVSO Headquarters May Differ Somewhat from This Limited Sample
Therefore All Requests for Data Should Be Directed To AAVSO Headquarters

SUNSET NOVAE

0000+56 FI Cas 115 15.4c KAI
0006-12 VW Cet " " Slightly variable in the range 13.5 - 14.0 between JD 197 and JD 217
KGA,BRJ,BGP,ARM
222 11.4 BRJ,CB,KGA,BGP
0012+65 V513 Cas 115 16.2c KAI
0043+559 BK Cas 208 14.7 BGP
0058+65 RR And " " Standstill continues, magnitude near 11.5 FEH,BGP,GRJ,KRT,DVW,HTT,KRB,
MEB,HMJ,SWT,DUR,VET,MRJ,GRJ,BTT,RAN,BCE,BCP,ARM,FAI,DUR,VEB
0109+37 FO And 212 13.8 KRB,BCE,KGA,GRJ,FEH,BGP,BRJ
0126+51 TY Per 220 11.9 RCT,BRJ,VET,GRJ,KGA,RAN,BCP
0130+518 FI Per 201 12.6 KTF,FEH,MRJ,VET,ARM
0139+37 AR And 197 12.2 BGP,VET
226 11.7 BGP,BRJ
0201+14 FT Ari " " Nearly steady at a mean magnitude of 10.78 MMI,BGP,BRJ,SWT,DUR,VET,KGA,
BGP,BGP,ARM
0204+57A FZ Per 199 12.9 RTT,ARM,BGP,FEH,VET,KGA
211 12.9 MEJ,KGA,BTT,ARM,BRJ,BGP,FCH,BTT,DUR
0207-43 WX Hyi 194 12.3 CB
0217+79 AM Cas 202 13.0 BRJ,BGP,MJJ,KGA,ARM
215 12.6 DUR,RTI,BGP,BRJ,MJJ,KGA,ARM
0235+56 FT Per 197 14.1c KAI
0236+37 FV Per 165 15.9c KAI
0243+37 MR Per 214 14.7 BRJ
0401+58 FO Per 202 13.2 CKT,BGP,BRJ,KGA
210 13.1 KTF,BRJ,BGP,FEH,DUR,CKT,KGA,BTT,ARM
221 13.2 BRJ
0408-71 VW Hyi 199 9.6 CB,CB
0411+50 KS Per 117 14.2c KAI
0501+04 AB Ori 211 14.5: Possibly a maximum earlier or later? CB
0547-05 CN Ori 204 12.5 DVW,CB,ARM,BGP
220 11.8 GRJ
0605+47 BS Aur 215 11.0 DUR,ARM,VEB,BCP,SCE,RAN,BRJ,BGP,FEH,DVW,HTT,KRB,MEB,HMJ,SWT,DUR,VET,GRJ,BTT
0609+15 V344 Ori 216 14.2 BGP
0611+15 GZ Ori 213 12.0 MJJ,DUR,HTT,BGP,BRJ,ARM,BCE,RAN,BTT,CB,GRJ
0640-16 RL CMa 206 11.5 CB,BGP
217 11.7 ARM,BCE,BTT,BGP,BRJ
0641+28 IR Gem 214 13.5 BCE,ARM,BRJ,BGP,FEH,BTT
0725+06 XV CMi 209 13.2 MFJ,CB
212 13.5 BRJ
0746-03 SV Pup 205 13.0 BRJ
0749+33 U Lyn 213 9.1 BGP,FEH,BGP,BRJ,KTB,MEB,HMJ,SWT,HE,MFJ,GRJ,BTT,ARM,DUN,SCP,SCE,RAN
0804+28 YZ Cnc 201 12.5 FEH
208 12.1 BGP
214 12.1 GRJ,MRJ,BGP
223 13.1 Probably still rising SCP
0814+73 Z Cam 203 10.4 MEB,FEH,BGP,BRJ,RMI,HCT,RAN,BCP,HTB,DUN,ARM
0827+25 AI Cnc " Brighter than last observing season but still showing only small range
" variations BGP,SCE
0854-51 CU Vel 204 13.0 BRJ
0855+18 VY Cnc 204 12.9 DUN,BGP
0955+12 K Leo 208 12.9 BRJ
1110+33 V442 Com 204 12.5 BGP
1133+01 T Leo 210 10.2 Super maximum KAT,SCP,DB,BGP
1251+27 GO Com 212 12.7 BGP
1640+25 AR Her 215 11.6 BRJ
1805-14 UZ Ser 202 13.6 BGP
1831+28 LL Lyr 205 14.3: CKT
1841+43 V345 Lyr 185 14.0c KAI
1841+37 AT Lyr 202 13.3 VET,BRJ,BGP,DUN
1848+34 CY Lyr 202 13.1 DUN,ARM,BRJ,BGP,VET
214 13.6 FEH,BRJ,BGP,DUN
1911-09 FO Aql 196 12.6 Revised date of maximum from Circular #2611: BGP
218 14.0 BGP



Circular No. 5159

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INTERNATIONAL ASTRONOMICAL UNION

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COMET BREWINGTON (1991a)

The following observations have been reported:

1991 UT	α_{1950}	δ_{1950}	m_1	*Observer*
Jan. 7.476	0h07m.0	−6°15′	9	Kiuchi
7.48	0 07.3	− 6 10	9.5	Camilleri
7.531	0 07.4	− 6 10	9	Bradfield

T. Kiuchi (Usuda, Nagano, Japan). 25×150 binoculars. Independent discovery. Communicated by H. Kosai.

P. Camilleri (Cobram, Victoria). 20×80 binoculars. Communicated by R. H. McNaught.

W. A. Bradfield (near Adelaide, S. Australia). Independent discovery. Communicated by A. C. Beresford.

Total visual magnitude estimate by D. H. Levy, Tucson, AZ (0.41-m reflector): Jan. 8.12 UT, 8.7.

(2060) CHIRON

K. J. Meech, University of Hawaii, writes: "CCD observations made on 1990 Dec. 16 and 17 with the University of Hawaii 2.2-m telescope on Mauna Kea indicate that the coma of Chiron is more extensive than has been seen before. A composite 540-s exposure through the *R* filter shows an extended coma/tail at p.a. ~ 293°. This closely agrees with the anti-solar direction, 292°3, at the time of the observation. The coma extends out to at least 2×10^5 km and is visible in exposures as short as 90 s. The absolute magnitude, $H = 6.2$, is significantly brighter than observations obtained during 1990 September with the same system. April and September observations showed that Chiron was continuing the trend of decreasing brightness seen since 1989 January. The December observations ($r = 10.65$ AU) suggest another possible outburst."

KR AURIGAE

Visual magnitude estimates (cf. *IAUC* 4682) by A. Boattini, Florence, Italy: 1989 Mar. 4.93 UT, 13.3; Sept. 30.99, 14.0; Oct. 23.90, 13.3; 1990 Feb. 23.79, 13.0; Apr. 16.81, 13.4; Nov. 17.05, 13.8.

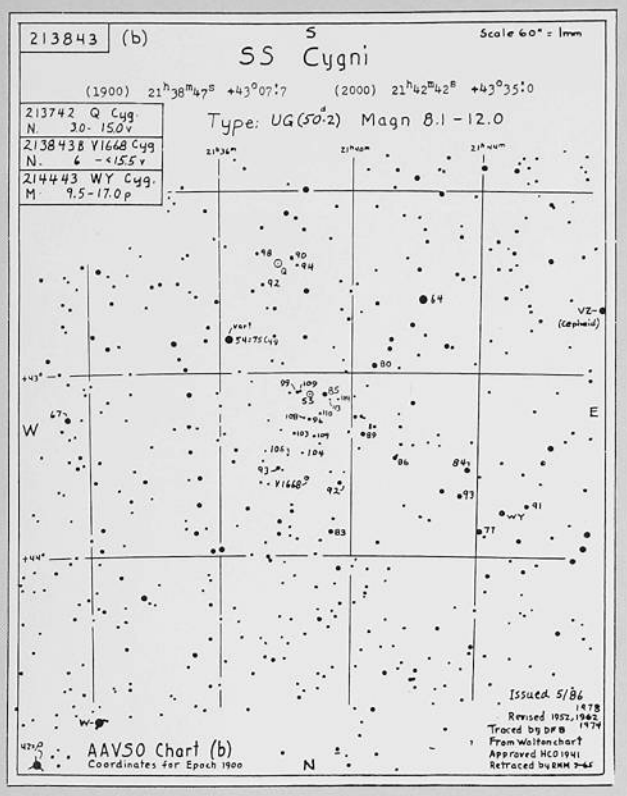
1991 January 8 *Daniel W. E. Green*

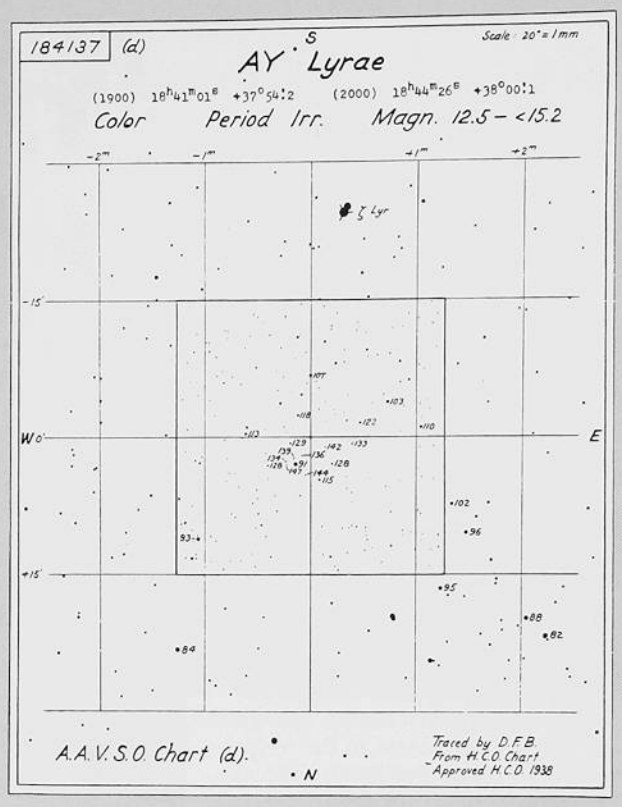
Each month the AAVSO issues a four-page publication called the *AAVSO Circular*. Observers send their observations to John Bortle in Stormville, New York. Mr. Bortle (with help from Charles Scovil in Stamford, Connecticut) has been putting together the *Circular* since November 1970. Observations are segregated into three sections covering dwarf novae, ordinary novae, and irregular/unusual variables. Individual stars are listed by name with date(s) when the star erupted or was otherwise involved in unusual characteristic activity. The AAVSO's director, Janet Mattei, often takes some *Circular* space to make special observation requests or sometimes to (mildly) berate us observers for ignoring certain variables for which she needs coverage. The *AAVSO Circular* has grown from covering less than 30 irregular variables in the first issue (November 1970) to its current coverage of more than 150 stars per issue.

Finally, the *IAU Circulars*, published by the Central Bureau for Astronomical Telegrams at the Smithsonian Astrophysical Observatory, often carry information and observations on special variable star activity. Although anything very unusual (novae, for example) would get duplicate coverage in *AAVSO Alert Notices* and *IAU Circulars*, the latter occasionally list recent observations of certain variable stars of longer-term interest in the astronomical community. (Recent stars of this nature have included KR Aurigae and V482 Cygni.)

Amateurs can subscribe to the *IAU Circulars* to get printed cards in the mail. For an additional fee, subscribers may access the Central Bureau's computer service and get all of this information on-line via modem. The Central Bureau also provides a service in which they deliver *IAU Circulars* to an electronic-mail address. Accessing the *IAU Circulars* electronically certainly is the fastest way to keep informed.

The Central Bureau is the world's official clearinghouse for all significant astronomical observations and discoveries, so there are reasons for subscribing to this service other than keeping informed on special variable star activity. Obtain further details and subscription rates by writing to the IAU, Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Ob-





servatory, 60 Garden Street, Cambridge, MA 02138.

Observing cataclysmic and other similar irregular variable stars is only one aspect of this avocation. There are many others, and in future articles we'll discuss them in further detail. However, if you are piqued by these stars and wish to learn more about observing them, you can request a "new observer's package" from the AAVSO (25 Birch Street, Cambridge, MA 02138); enclose a self-addressed, stamped envelope. Non-AAVSO members can subscribe to the *AAVSO Circulars* for a modest price; write AAVSO for details.

In keeping with the long custom of featuring specific variable stars in this column, this time I'd like to feature a couple of cataclysmic variable stars which routinely appear within the pages of the *AAVSO Circulars*. The first star is one of the easiest to find and observe in its class. **SS Cygni** has been featured numerous times in this column, and for obvious reasons. It's easy to find and observe; and it's as close as we're going to get to a bright cataclysmic variable in the Big Dipper or the Southern Cross, so take advantage of it. About every six weeks — sometimes more, sometimes less — SS Cygni brightens from about magnitude 12.0 to about 8.1. This brightening takes place in less than a day. Once at maximum, the star might stay there for only a couple of days or remain in outburst for a week or so; it's unpredictable. Fading back down to minimum light usually takes about a week.

Finding SS Cygni is especially easy in equatorial mounted telescopes. We normally start at Deneb and then move east and a little south (about a 4° move) to the 3.7-magnitude star 62 (Xi) Cygni. Then we slide further eastward in right ascension about 6.5° to the 5.4-magnitude star 75 Cygni. The star 75 Cygni is on the AAVSO "b" chart for SS Cygni and is the easternmost member of a 1/2° asterism of six stars taking the shape of a triangle (no stars in the northeast side of the triangle). It's a short, 1/2° hop from 75 Cygni to SS Cygni; look for the three stars forming an equilateral triangle (magnitudes 8.5, 9.6, and 9.9) near the star; when it is flaring, it obviously breaks up the triangular shape.

The route to SS Cygni reminds me of a story involving the late comet discoverer and variable star observer Leslie C. Peltier. One summer night back in the 1960s, several AAVSOers were visiting Leslie at his home in Delphos, Ohio. As the sky darkened, someone suggested a race to see who could find SS Cygni first. The two observers taking the challenge pointed their telescopes toward some neutral point in the sky, and when Leslie shouted "Go!" scopes and bodies went wildly flailing about as the search took place. The whole scene took Leslie by surprise, and he roared in laughter, almost falling over in his chair in the process.

A second cataclysmic variable you might try is **AY Lyrae**. The field this star is in is easier to find than SS Cygni's field, but I have found AY Lyrae to be very difficult to observe in outburst because it is much fainter than SS Cygni. AY Lyrae at outburst can only be in the 13th magnitude range, so it is a challenge to amateur instruments. To find the field of AY Lyrae, simply locate the star zeta Lyrae (the "other" bright double star next to Vega) and use the accompanying chart. □

Paul L. Sventek and Tom Arnold are highly skilled variable star observers who are members of the Houston Astronomical Society. They wish to acknowledge that AAVSO charts are reproduced by special permission of Dr. Janet A. Mattei, AAVSO. Additionally, reproduction of materials from the International Astronomical Union is through the courtesy of Daniel W. E. Green, SAO.

Scanning the Literature

Galaxies and Their Magnitudes, Part Five

by Brian A. Skiff

This time I'd like to finish our discussion of surface brightness as it relates to galaxies and to tie up a couple of loose ends.

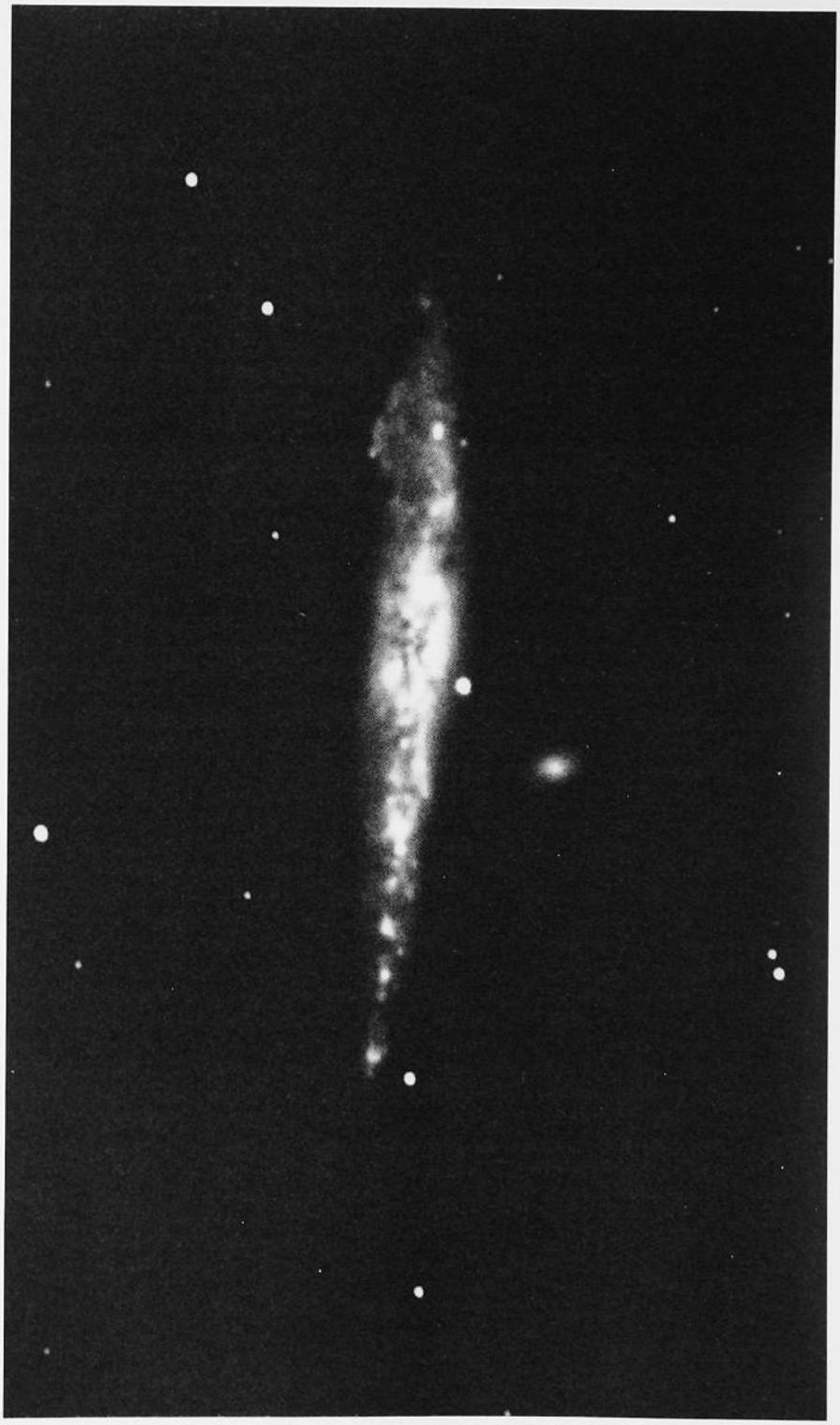
First, some loose ends from the last issue. The illustration in that article, a contour plot showing isophotes for the galaxy pair NGC 4631/4627, was taken from a paper by E. Hummel and R.-J. Dettman ("Radio Observations and Optical Photometry of the Edge-On Spiral Galaxy NGC 4631," *Astronomy & Astrophysics* **236**:33 [September I (1990)]). Ralf Dettmar kindly supplied a reprint of the paper to reproduce the illustration, but the citation to the paper was inadvertently omitted. I did not generate the plot, as some thought.

I also was a little sloppy last time about the sky brightness in the V (yellow) and B (blue) passbands. The sky in V (free of light pollution) is about magnitude 22.0 per square arcsecond, but in B it is full magnitude fainter. This is because the dark night sky is dominated by light scattered by zodiacal dust, even at the ecliptic poles, and so is about the same color as the Sun. In addition, the V band includes the bright atmospheric oxygen emission line at 5577Å from the night airglow, whereas the B band is free of such atmospheric lines and thus darker. Further, the average color of the background starlight is roughly that of a G or K giant star. The combined B-V color ends up close to 1.0, and so in B the sky is that much fainter than in V.

My error came in saying that the B magnitude 25 isophote used to define the sizes of galaxies was three magnitudes fainter than the night sky. But that is comparing the V sky against the galaxy in B — apples and oranges. The standard galaxy isophote is actually only two magnitudes, or a little more than six times fainter than a true-dark sky in the blue.

Several readers complained that my switching units, between magnitudes per square arcsecond and square arcminute, was confusing. From here on out, then, we'll deal in square arcminutes, mainly because the numbers are closer to what one is used to in visual observing. From the computation last time, we can figure out how bright the sky is in these units:

True-Dark Night Sky: V=13.1



NGC 4631 and NGC 4627 photographed by Kim Zussman (modified 11-inch f/10 SCT, hypersensitized Tech Pan film, 120-minute exposure).

NGC 4631/27 and nearby galaxy NGC 4656 photographed by Martin C. Germano (8-inch f/5 reflector, hypersensitized Tech Pan film, 50-minute exposure).

(B=14.1) per square arcminute.
Standard Galaxy Isophote: B=16.1 per square arcminute.

As we saw last time, the typical Shapley-Ames galaxy (those brighter than about total V magnitude 11.5) has a mean surface brightness of around 13.5, roughly 50 percent fainter than the sky. As explained last time, these low contrast levels are actually easy to detect with your eye — patently obvious, since we go out and find such galaxies all the time!

How is the surface brightness magnitude calculated? The *RC2* lists this data explicitly for 1700 galaxies. The formula is: sfc. br. = B(std) + 5logD (std) - 2.5logR(std) - 0.26, where B (std) is the B magnitude within the standard dimensions, D(std) is the length of the major axis in arcminutes, and R(std) is the ratio of the long and short dimensions within that isophote. Note that this formula is strictly true only for B magnitudes and dimensions. (The blue-sensitive photographic plate still dominates in this business, so we're stuck with it for now.) Because the colors of galaxies are similar, it is approximately correct to convert the resulting surface brightness to V by subtracting the B-V color of the galaxy. Even though the standard V isophote is larger, this is compensated by the fact that more light is included in the total.

The first problem is that we've been dealing with total magnitudes, not just the light within the standard isophote. In the *RC2*, the average offsets are listed for different types of galaxies:

ellipticals: 0.25 magnitude
lenticulars: 0.13 magnitude
spirals: 0.11 magnitude

The total magnitudes are up to a quarter of a magnitude brighter than the magnitude within the standard isophote. Note that this puts the lie to those who claim the total magnitude doesn't accurately reflect what's visible in the eyepiece, but should be one or more magnitudes fainter. Since we can see something like 75 percent of the total light of a galaxy, the total magnitude is a good measure (along with the mean surface brightness) of the visibility of an object.

According to the *RC2*, NGC 4631 (our example from the last issue) has a total B magnitude of 9.75. It is a late-type spiral, so the isophotal magnitude is 9.75 + 0.11 = 0.86. The size listed is 15'.14x3'.31; the ratio R is thus 4.57. So we have:

sfc. br. = 9.86 + 5log(15.14)
-2.5log(4.57) - 0.26
= 9.86 + 5.90 - 1.65 - 0.26
= 13.85 magnitudes
per square arcminute.

Even though we've kept the numbers to a hundredth of a magnitude here for the calculations, the *RC2* notes that the result is uncertain by plus or minus 0.25 magnitude, so it is advisable when doing these calculations to round them to a tenth at the end.

The B-V color listed in the *RC2* is 0.54; the V surface brightness is thus 13.85 - 0.54 = 13.31, let's call it 13.3 per square arcminute. The galaxy is about 0.2 magnitude (20 percent) fainter on average than a true-dark night sky. But some parts are much brighter. The Hummel & Dettmar plot peaks at about V magnitude 10.5 per square arcminute, ten times brighter than the sky, enough to make the galaxy an easy target from light-polluted sites, made all the more attractive by its whopping size.

I hope this series has led you to be more critical about not only catalogue information, but also your own observing. The eye is a contrast detector, not so much a detector of brightness per se. As a result, knowing the surface brightness of a galaxy is no less important than having a reliable total magnitude in hand when making up an observing list. By paying attention to what surface brightness levels you can see with a given telescope and at a certain observing site, you can assess pretty well ahead of time how difficult an "unknown" galaxy will be when used in combination with the total magnitude. By testing yourself at fainter and fainter limits, you'll find yourself improving your visual skills — and you'll get more satisfaction out of observing. □

Brian Skiff's knowledge of the literature includes a vast mental index of journal articles.

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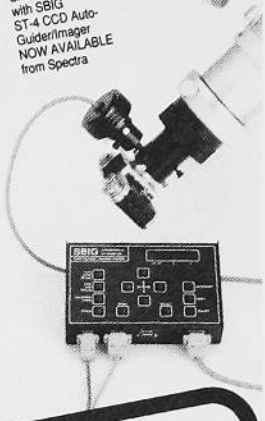

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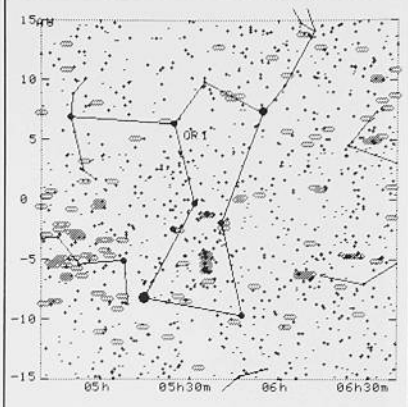

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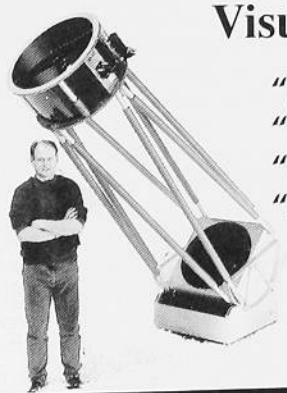

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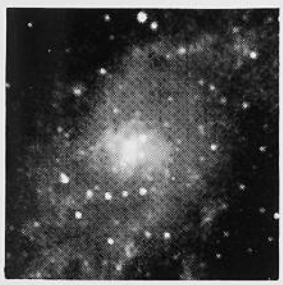
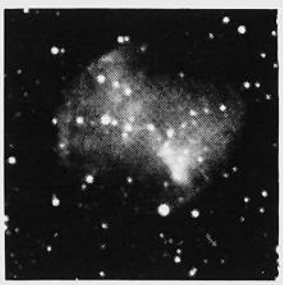

M33, 2 min, 8" f/3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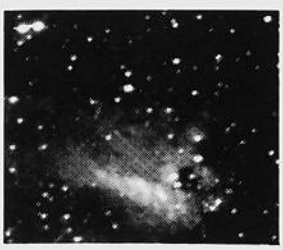
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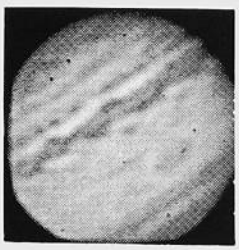
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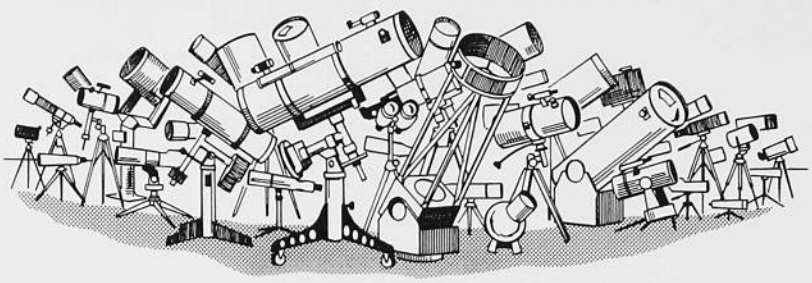

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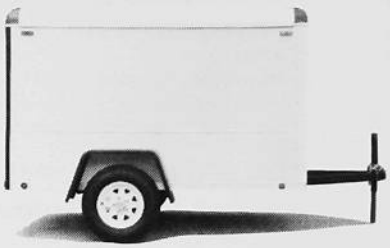

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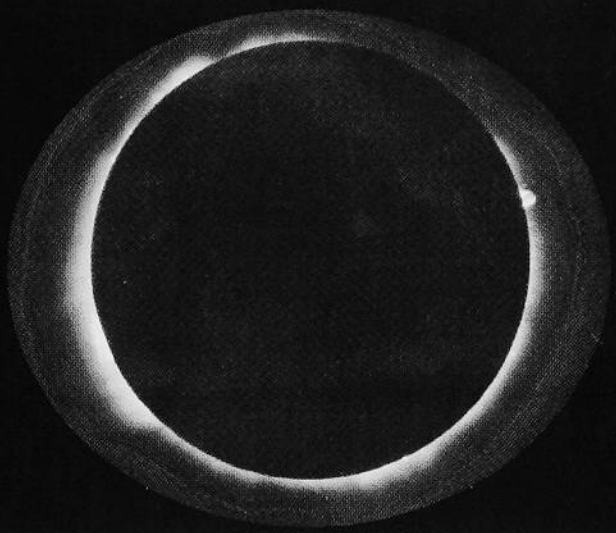

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